OCTOBER 12, 1961

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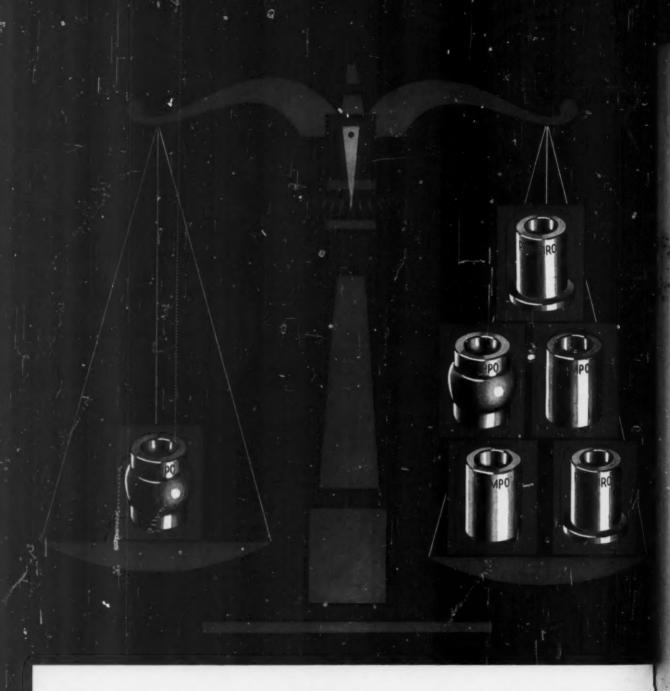
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COLD-HEADING PLASTICS

Contents, Page 3



Every bearing order "weighs" the same at Bound Brook

We give the same special attention to each order . . . every step of the way, from engineering through production through shipping. Our two manufacturing plants give us the extra flexibility to meet equally well the needs

of the smallest manufacturer . . . or the largest. Whatever your quantities and designs for self-lubricated iron and bronze bearings . . . you can rely on Bound Brook for "custom" service and prompt deliveries.



BOUND BROOK BEARING CORPORATION OF AMERICA

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Pioneer in Powder Metallurgy Bearings and Parts . Plants at Bound Brook, N.J. and Sturgis, Mich.

Circle 201 on Page 19



Out of the Ross research lab has passed the most extensive line of valves in the air control world

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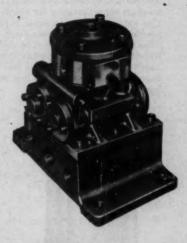
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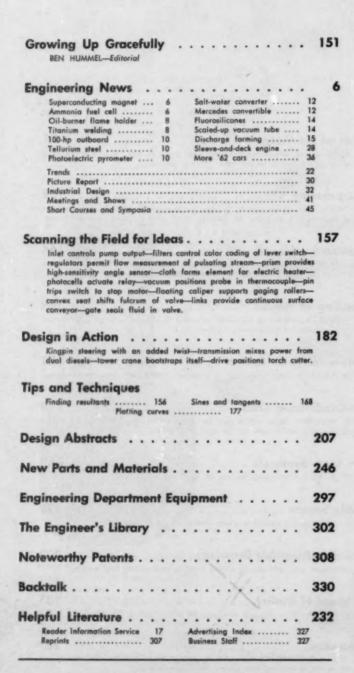


4017 Mahoning Ave., Warren, Ohio - EXPORT: Capperwold Steel International Co., 225 Broadway, New York 7, N. Y.



Front Cover: Cold-heading of plastic parts furnishes the inspiration for this issue's cover by Farnsworth. On Page 169, author H. S. Norris

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Volume 33 — No. 21

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DESIGN ENGINEERING NEWS

Cryogenic Coil Generates 43,000-Gauss Field

Coreless Supermagnet Weighs 1 lb

Pritsburgh—One of the most sought-for goals of modern, technology has been achieved: Scientists at Westinghouse Electric Corp. have developed a superconducting magnet. Vigorously sought in dozens of laboratories throughout the world, the magnet was considered theoretically impossible to construct until a year or two ago.

Resembling a doughnut, the 1-lb magnet creates a field of 43,000 gauss—twice as strong as that of a 40,000-lb iron-core electromagnet. The conventional magnet would need its own 100-kw (or larger) powerplant; the super magnet can be energized by an automobile storage battery. The only continuous power draw is the few watts necessary to overcome lead-wire losses.

Saturation No Problem

Because the magnet has no iron core, it opens new possibilities. Iron-core magnets begin to saturate at about 20,000 gauss, and can be driven to greater strengths only by the brute-force applications of power.

"A superconducting magnet will allow us to perform some of the most crucial scientific experiments of our time," declares Dr. J. K. Hulm, associate director of Westinghouse research laboratories. "It enhances considerably our chances for the direct, large-scale generation of electric power. It makes possible a whole new generation of powerful atom smashers. It increases the possibility of a magnetic 'bottle' in which the vast energy of the hydrogen-bomb (fusion) reaction can be harnessed for useful power. It makes more feasible some of the far-out methods proposed for space travel."

The magnet is wound from a half-mile of superconducting wire about the diameter of a sewing thread. The wire, a niobium-zirconium alloy, carries a 20-amp current. At the same current density, a scaled-up wire,



Field strength preduced by the 2-in. diam, 1.5-in. long coil is more than double that of a conventional magnet the size of an automobile. Power losses are so small that the super magnet can be kept energized by the meager output of an ordinary storage battery.

having the diameter of a piece of chalk, would carry 200.000 amp.

Immersed in a vessel of liquid helium, the coil is kept near -450 F. Energy required for cooling is only a small fraction of that needed to create a comparable magnetic field with a standard electromagnet. Essentially, the super magnet produces almost all of the magnetism "for free."

Ammonia: Newest Fuel for Fuel Cells

MILWAUKEE—Researchers at Allis-Chalmers Mfg. Co. are now experimenting with ammonia as a fuel for fuel cells. Earlier work has involved hydrogen, hydrazine, methanol, and other fuels.

Advantages of the ammonia fuel cell, according to Allis-Chalmers, are that ammonia is low in cost and is easily condensed. In addition, storage, transportation and handling

techniques are well established.

In the laboratory-size ammonia fuel cell, the electrode material is porous carbon. Catalyst, platinum black, is applied to the electrodes.

The electrolyte, concentrated potassium hydroxide, is held in a porous diaphragm between the electrodes. Ammonia is fed to the anode side of the cell and oxygen to the cathode. The resulting chemical reactions cause an electric current to flow between the electrodes in an external circuit. Principal products of the reaction are nitrogen and water.

Experiments to date have been carried out at low temperatures and pressures. While increasing temperature of operation increases cell output, more experimentation is needed on larger cells to fully determine all of the many factors affecting the operation.

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Report No. 11,806 From Oilgear Application-Engineering Files

HOW OILGEAR HEAVY-DUTY Any-Speed HYTAC* DRIVE SYSTEMS ON Anaconda's NETFOIL LAMINATING AND COATING MACHINES HELP SPEED PRODUCTION—CUT COST

USER: The Anaconda Aluminum Company, Louisville, Kentucky, Fair Lawn, New Jersey, Terre Haute, Indiana (Machine Builaer — New Era Manufacturing Company, Hawthorne, New Jersey — successor to Meisel Press Manufacturing Company, Boston, Mass.)

PROBLEM: Main and Rewind Drive Systems for two, new, high-speed laminators to bond aluminum foil as thin as 0.0002" to paper stock ranging from 15-lb tissue to 0.020" carton and food board. In addition to laminating, these "presses" must simultaneously coat and/or color the foil.

REQUIREMENTS: 1. Accurate, wide range, dependable tension control to accommodate Anaconda's complete range of laminating foils and paper stock. 2. Infinitely variable, stepless speed range from 0 to 1000 fpm—cap-

able of an optimum, continuous 850 fpm running speed.

3. Maintain tension accurately in "stall" condition indefinitely without overheating—and then pick up speed smoothly and quickly without snapping the sometimes fragile web. 4. Reduce costs through reduction of scrap, repair parts inventories, and machine downtime... operate at nearly three times former production speeds.

5. Must be: compact, to conserve valuable floor space; economical on electric power input; capable of continuous, three-shift operation.



ABOVE: One of Anaconda Aluminum's new, Oilgear-equipped, high-speed fall laminating and coating presses—revind end—as installed at their Louisville Kentecky, Laminating Plant. Roll cores—8 ¾ dia... web width—from 23 to 52 ... roll diameters—to 60 ... roll weights—to 4500-tb. Tension range—from ½-tb/in. to 4-tb/in. depending on weight of lamination being processed Arrows (A), (B)—Oilgear Variable Displacement Drive Pumps. Arrow (C)—es of two pushbutton control stations at opposite ends of the press—3 emergency "stop" buttons are located at other positions.

SOLUTION: Oilgear Any-Speed HYTAC* Main and Rewind Drive and Tension Control Systems—as symbolized in the schematic sketch-above right. These compact, heavy-duty systems have successfully met or exceeded all originally specified requirements in continuous, three-shift, high-speed operation. Oilgear Drives were selected for these new machines because of: 1. The enviable record of maintenance-free long-life in several Anaconda Aluminum Plants. For example - six out of seven original, 300fpm laminating presses at Louisville are Oilgear-equipped ... two operating continuously since 1946. These 14year-old drives—and two others—have NEVER required naintenance other than oil changes and an occasional drive haft seal. The other two Oilgear Drives-installed in 1948—were disassembled three years ago merely for a preventive maintenance check—haven't been "touched" tince. 2. Oilgear's accurate, dependable tension and speed control over a wide range—for smooth, precise, troublee operation on Anaconda's entire range of laminating stocks. 3. Space saving-Oilgear Drives occupy less floor pace . . do not require high-speed blowers for cooling— can hold stall-speed indefinitely without overheating. 4. Economy—in electrical power input, maintenance, virtually eliminate costly machine downtime and spare parts inventories . . . and in many cases—at lower installed cost.



Oilgear's patented Any-Speed MYTAC® Drives (details not shown above) hold any preselecte speed within ± 0.1% under constant force leads—within ± 0.5% regardless of load, electropower variations, or temperature and viscosity changes . . . provide cushioned starting, remoi jagging and threading . . . smooth, even let-off or build-up tensions . . . constant forque ac justable tension . . . hydrodynamic braking. Applied to center shaft winders, Any-Speed MYTAC Drives automatically sense and compensate for changes in overall machine speed, and courtonically provide constant, adjustable, or tepering tension ever a 20.1 winding rang without dance or follower rolls.

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Unbelievable? — Not to Oilgear Users! There are case histories upon case histories on file of machines equipped with Application-Engineered Oilgear Drive Systems that are rolling along—efficiently, quietly—with over 20 years of trouble- and maintenance-free service! Some additional installation-proved reasons . . . the greater accuracy, precision control of speeds, torques, tensions . . . new economies of operation, installation, and valuable floor space . . . are why more and more Oilgear users in the paper, printing and converting, food and beverage, marine, chemical, pharmaceutical, primary metals, metalworking, textile, rubber, military, and other industries all agree that . . .

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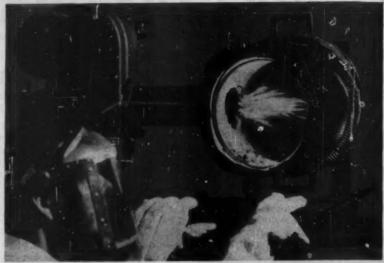
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Flame Holder Improves Oil-Burner Efficiency

NEW YORK—A metal grid that will fit over the discharge nozzle of almost any oil burner gets more heat out of the fuel. Developed by Esso Research and Engineering Co., affiliate of Humble Oil and Refining Co., the device molds the flame pattern for more efficient combustion, cleaner heat, and quieter burner operation. During one full year of testing, it reduced home-heating costs by 20 per cent or more.

While studying fundamentals of combustion in high-pressure oil burners, Esso researchers found that in the central region of the flame pattern no burning takes place. Further checking led them to conclude the velocity of the fuel-air mixture in this region is greater than that of the flame front. The grid was developed to dissipate part of the velocity head and allow the flame to burn close to the burner port. According to Esso spokesmen, it can be installed on 85 per cent of the oil-fired home-heating systems now in use.

Field tests show the grid drops stack temperatures from an average of 600 to 390 F. Excess air can be reduced from about 90 to 37 per cent, and efficiency increases from 71 to 83 per cent.



Flame is smaller, whiter, and hotter after the velocity-dissipating grid is added over an oil-burner nozzle. Normal burner produces a long flame that spirals outward in the shape of a thick-walled megaphone—no burning takes place in the center. The grid, by slowing up part of the oil vapor, allows combustion to get started in the center. Once started, the flame quickly spreads through the mixture. Field tested on private-home heating systems, the grid caused furnaces to use from 20 to 43 per cent less fuel.



Progress Reported in Welding Titanium

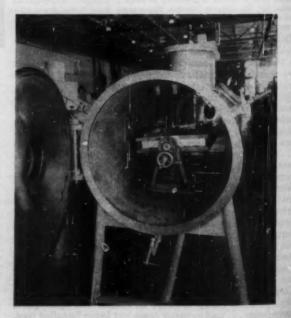
COLUMBUS, OHIO—New welding techniques developed at Battelle Memorial Institute have resulted in crack-free welds in 2-in. titanium-alloy plate. Previously, 5/6-in. plate was the thickest titanium alloy that could be welded, and extensive joint cracking occurred in this.

The welding study, sponsored by the Navy, may eventually lead to new hulls for submarines. Titanium alloys as strong as steel weigh only two thirds as much. They would give submarines greater speed and payload capability, and allow them to dive deeper.

Best combination of yield strength and impact prop-

erites were obtained with Ti-6Al-4V plates and an experimental 5Al-2Cb-1Ta alloy filler wire. Filler alloys are still being studied to further improve weld strength.

Crack-free welds (cross section, left) were obtained in an argon-atmosphere chamber (right). Heat input of 45,000 joules per in. was produced with a 365-amp, 32-v arc at a feed speed of 15 in. per min.



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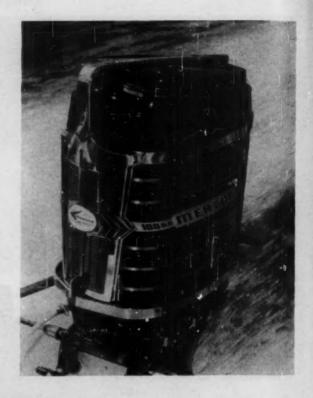
Outboards Clear the 100-hp Hurdle

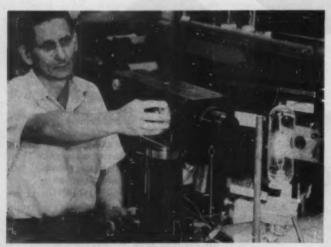
FOND DU LAC, Wis.—Merc 1000, the first 100-hp motor for outboard cruisers and runabouts, will give the largest of these boats the handling characteristics and flexibility of a small one. Designed by Kiekhaefer Corp., the newest addition to the Mercury-motor series will not start a horsepower race, according to the company; it was developed because the big boats don't have enough power to get up to cruising speed on one motor.

More compact and no heavier than most 75-hp motors, the Merc 1000 is completely new from powerhead to prop. It is a six-cylinder in-line motor with a 90-cu in. displacement. Features include automotive-type fixed-jet carburetors, hydraulic shock absorbers to absorb impacts when the motor encounters submerged obstacles, and an optional long shaft (for boats with 20-in. transom height).



New cylinder head (left) "squishes" fuel-air mixture inside the combustion chamber. Greater power and more efficient combustion result, according to Kiekhaefer Corp. Other benefits include smoother idling, quicker response, and quieter operation at all speeds. Merc 1000 (right) is one of two engines using the newly designed heads.





New Accuracy for Pyrometers

Radiance matches are detected photoelectrically, rather than by the human eye, in a new pyrometer developed by the National Bureau of Standards. Precision of the device is 0.02 C at 1063 C, compared to 0.3 C for the NBS optical pyrometer. After stability testing and calibration, the photoelectric pyrometer will be used to calibrate optical pyrometers and tungsten-strip lamps, and to redetermine the platinum point. Inaccuracies of up to 0.2 C have resulted from differences in size of the source viewed, but NBS scientists have worked out a simple procedure for estimating source size. The procedure allows them to apply a correction factor. Long-term stability of the pyrometer is still being studied.

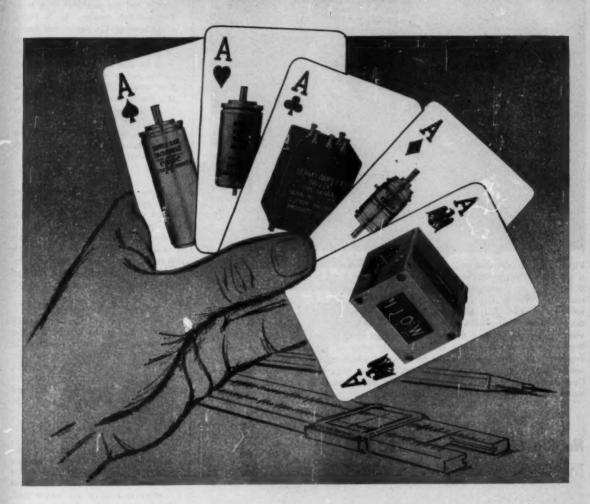
Tellurium Steel Proves Fastest to Machine

Hammond, Ind.—Spark-plug shells were recently machined from a new tellurium steel at 618 surface feet per min—3½ times the normal speed. And although feed rates were increased 1/3, up to 0.0035 in., tool wear was normal.

The work, conducted on an experimental basis by LaSalle Steel Co., shows that tellurium has a very beneficial effect on machinability of steel. Tests were made on 13/16-in. hexagon bars of La-Led X, LaSalle's new tellurium steel, with an advanced six-spindle automatic screw machine. Spark plugs were selected because they are produced by the millions each year and considerable product information and comparative data are available.

While 618 sfm was not the maximum speed at which the steel could be machined, LaSalle spokesmen believe it is the fastest speed ever used to machine steel bars on an automatic screw machine. And according to one of the observers of the tests, R. R. Rhodehamel, vice president, Cone Automatic Machine Co., "The steel offers a new concept in machinability, and it will bring about development of new automatic screw machines to run at higher speeds ... Cone is now working on a series of such machines."

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Five 'Page' Water Still



Victims of sea disasters will no longer die of thirst. The Army has developed a gadget, called a "sit still," that makes enough fresh water to keep one man alive. The do-it-yourself converter consists of five letter-size sheets of various materials: Black plastic film on top, paper toweling or cloth, water-repellent screen, aluminum foil, and cloth backing. The five-sheet unit is dipped in the ocean, excess water is drained off, and the aluminum foil is wiped dry. The sheaf is then exposed to the sun's rays (or sat upon at night or on a cloudy day) and heat penetrates to the aluminum foil which is cooled by the salt-water-soaked cloth. The few drops of fresh water which condense on the foil can be soaked up with a sponge. According to Army engineers at the Research and Development Laboratories, Fort Belvoir, Va., larger models of the device can be made by adding more layers of materials.

No Big Changes in the 220 SE



Stated for production next spring, but shown at the recent Frankfurt Auto Show, the new Mercedes-Benz 220 SE convertible is patterned after the coupe announced earlier. Slightly longer than earlier convertibles in this series (192 vs. 185 in.), the new model combines the smooth clean lines and long low silhouette of sports-car styling with the performance, comfort, and safety of a touring car. The five-passenger convertible retains the same fuel-injected Daimler-Benz six-cylinder engine for another year. The 140-cu-in. powerplant (3.16-in. bore x 2.87-in. str. ke) develops 134 hp at 5000 rpm. Top speed is 106 mph. Disc brakes and self-adjusting steering gear are standard equipment.

Topics

Polyethylene protects such diverse groups as the crew of a nuclear submarine and the neighbors of a backyard golf-ball swatter. U. S. Industrial Chemicals Co. reports that heavygage polyethylene panels-some over an inch thick-pass military specifications for shielding against neutron radiation and are being used aboard nuclear vessels. Meanwhile, a golfer who is trying to correct a slice submits to U. S. I. the suggestion that an 8 by 10 ft, 6-mm thick sheet of polyethylene film, strung between posts a few yards from a tee, would stop even the wildest practice drives.

There is nothing like a dame—or even the voice of one—to warn a pilot when something is going wrong with his plane or engines. This is the theory of Ferranti Ltd., London, which aims to replace the customary trouble lights and dials on an airplane's instrument panel with recorded messages made by a "girl with a golden voice."

Rubber wears off the world's automobile tires at the rate of 2 billion pounds a year, according to Dr. S. D. Gehman, manager of physics research, Goodyear Tire & Rubber Co. Even, so, Dr. Gehman points out, no other material could do the job as well, and the rate of wear is less than 0.01 in per 1000 miles.

Headlight glare is counteracted automatically in a rear-view mirror invented by Jacob Rabinow and Arthur O. Morse. There is a plain glass and a space in front of the mirror itself. Bright light coming through the car's rear window strikes the mirror and a photocell, actuating an electromagnet that moves the mirror and glass apart. This action draws in a dark liquid, stored in the space, which darkens the reflection and keeps it dark as long as the glare remains.

Man may bring smog to the moon. The "transparent-dome" concept of providing a lunar village with an artificial atmosphere would mean certain trouble, says Dr. Gerald A. Guter of Aerojet-General Corp. Rays of the sun—much more intense on the moon than on earth—would cause the nitrogen and oxygen in the artificial atmosphere to form oxides of nitrogen, a major contributant to smog. A smog preventive, says Dr. Guter, would be a shield to filter out ultra-violet rays.



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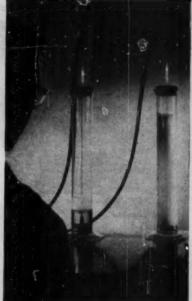
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White globs of fluorosilicone compound remain unaffected by all solvents except acetone (second from left, above). Other solvents (from left to right) include water, JP-4 jet fuel, carbon tetrachloride, and ethyl alcohol. The compound floats in carbon tetrachloride. When fluorosilicone fluid is added to a contaminated solvent foamer (cylinder at near right) and air is pumped in, the fluid causes foam to fall as fast as it is formed.



Silicones Improve Their Solvent Resistance

MIDLAND, MICH.—Fluorosilicones, a new line of heat, cold, and oxidation-resisting materials, have come out of the pilot plant and are available for industrial applications, according to Dow Corning Corp. First developed as a rubber, fluorosilicone materials now include fluids, greases, and compounds for use as lubricants, hydraulic fluids, and defoaming agents.

While having many of the useful properties of silicones, the new semi-

inorganics have one feature that is strictly their own: They are exceptionally resistant to solvents, fuels, and chemicals. Inert and insoluble, they have a high order of lubricity and can be used over a temperature range of -40 to 400 F in open systems. Upper limit is 550 F in sealed systems.

Basic member of the new family is the fluorosilicone fluid. From it, grease-like compounds are produced by blending in an inert silica filler. Thicker greases can be obtained by adding lithium soap to the fluid.

High - performance, rubber - like fluorosilicone sealants that cure at room temperature have also been developed for specialized applications. Dow is now producing these sealants in limited quantities.

Chief drawback to use of the fluorosilicones is their high cost—fluids run \$25 per lb, grease-like lubricants \$35-40, and soap-thickened lubricants \$46. Dow is confident, however, that the cost will come down.

Scaled-Up Electron Tube

Prittsburgh—Electron-optics researchers at Westinghouse Electric Corp. have a new tool at their disposal. The device, a demountable vacuum system, is expected to be a big help in the never-ending battle to improve electron tubes.

Basically a 1.5-ft diam by 4.5-ft long bell jar, the new instrument contains adjustable tube parts and a vacuum system that includes a large ion pump. Large-scale models of electron guns will be set up inside the jar and studied. The interior can be evacuated to 10-6 mm of Hg pressure, and tube parts can be adjusted by a system of magnets, rods, pulleys, and wires.

Mounted on rollers, the bell-jar frame moves forward on rails to cover the tube parts.

Big Metal Parts Formed By Capacitor Discharge

Dallas, Tex.—During the last ten years, progress in electrical-discharge methods have led to one of the most radical departures from convention in the history of metal-working. One of the latest developments in the field, announced by Electro-Hydraulics Inc., Dallas, Tex., centers around a new line of capacitor-discharge equipment that operates on ordinary 110-v power. It is similar in concept to explosive forming.

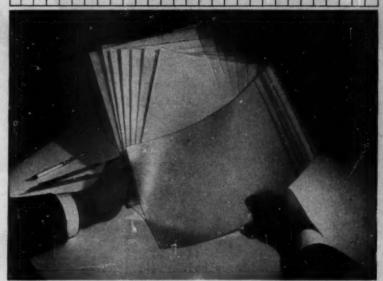
In the Electro-Hydraulic operation, electrical discharge is separated from the workpiece by a fluid medium which provides a "coupling" between the explosive spark discharge and metal. Fluid has the effect of rounding off the pressure pulse, reducing the peak and prolonging the time over which the pressure acts. Electrodes in the machine are connected by an initiating materialmetal wire or foil-which adds intensity to the pressure wave and controls its path. When activated, the initiating material is transformed into a channel of plasma which expands against the transmitting medium (fluid). Pressure buildups as high as 500,000 psi are produced.

Since its reaction is essentially linear, the EHI method can produce parts similar to those presently being done by chemical explosion. Die design departs from normal forming in that dies are completely enclosed for both internally formed and draw-type parts.

The existing EHI unit, a 15,000-joule machine, is large enough to form internally expanded tubular parts 10 in. diam by 4 ft long, and flat sheet parts to 196 sq in. Bigger units can be built, however; only the size of the physical plant and dies limit the size of the fabrication.

EHI machines will successfully fabricate by electronic welding, locking, bonding, or laminating, and by die embossing, shaping, flanging up to 90 deg, blanking, etc. Tolerances of 0.0005 in. are achieved. According to EHI spokesmen, their equipment could produce finished automobile body shells or small boat hulls 12 to 16 ft long.

DRAFTING TRENDS



Appearance is not a good indicator of drafting film workability or reproduction quality—see test offer below.

In drafting films, it's the coating that counts

Film Similarities

All drafting films share one common characteristic—every major brand employs a polyester base. This polyester material may vary somewhat in grade (from clear to milky) or in gauge (from .002 to .007). However, its properties remain so nearly identical that no appreciable difference in print-back speed can be noted by exposing diazo material through the uncoated film. Accordingly, all polyester films have these unique features: dimensional stability, transparency, flexibility, moisture-resistance and tear strength.

Coating Differences

These advantages mean nothing to the engineer, draftsman or architect until a surface receptive to pencil and ink is put on the film. Post applies three distinct micro-coatings to its polyester film, baking these elements and the film at such high temperatures that they are literally fused. This process also "preshrinks" the material, endowing Polytex with slightly greater dimensional stability.

More Drafting Latitude

The net result of the exclusive Post coating process is the most durable drafting film surface available—a surface on which, if circumstances demand, you can use the hardest grade of pencil without destroying the coating. Some pencils work better than others, of course. Plastic-based pencils are best of all when permanency or washability are considered.

Test Offer

To convince you, regardless of previous or present drafting film experience, that Post Polytex offers a superior coating with outstanding erasibility, pencil and ink adhesion, a free Polytex test kit is yours without obligation. We'll mail an $3\frac{1}{2}$ x 11 drafting film sample, plus a vinyl eraser and drafting pencil assortment, packed in a Post Pocket Protector. Write for it on your letterhead today. Frederick Post Company, 3652 N. Avondale Avenue, Chicago 18, Ill.



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HELPFUL LITERATURE

Descriptions of items start on Page 232. Starred Items are from Sept. 28 Issue.

Electrical, Electronic

- Electrical, Electronic

 482 Pruchsian Instruments. 6 pp. Helipot Div., Backmen Instruments Inc.
 483 Multiple Switches. 12 pp. Switchcroft Inc.
 481 Adjustable-Speed Drives. 32 pp. General Electric Co.
 487 Gyroscopic Instruments. 60 pp. Kearfott Div.,
 General Pracision Inc.
 485 Serve Components, Pethages. 16 pp. Trensicoll
 Div., Daystrom Inc.
 481 Silliese Diades, Rectifiers. 10 pp. Eris Essister
 Corp.
 483 Differential Transformers. 12 pp. Automatic
 Timing & Controls Inc.
 484 Panel Instruments. 6 pp. Weston Instruments
 Div., Daystrom Inc.
 485 Silliese Rectifier. 8 pp. Rectifier Components
 Div., Daystrom Inc.
 485 Silliese Rectifier. 8 pp. Rectifier Components
 Div., General Electric Co.
 489 Switch, Thermester Packages. 16 pp. Metols
 & Controls Inc., Oliv., Texas Instruments Inc.
 480 Multiple Connectors. 6 pp. AMP Inc.
 481 Basis Switches. 2 pp. Micro Switch Div., Minneapolis-Honeywell Regulator Co.
 485 Sermanium Diades. 4 pp. National Transistor
 Mfg. Inc.
 486 Digital Transducers. 4 pp. Louis Allis Co.
 485 Digital Transducers. 10 pp. Monitor Controller
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 486 Sermanium Diades. 4 pp. National Transistor
 Mfg. Inc.
 486 Centrel Centrel System. 4 pp. ElectroMachanical Div., Lear Inc.
 487 Serva-Mater Package. 4 pp. Aero Hydraulics
 Div., Vickers Inc., Div., Sperry Rand Corp.,
 488 Sewhelmer Package. 4 pp. Aero Hydraulics
 Div., Vickers Inc., Div., Sperry Rand Corp.,
 489 Meta-Nave Service Switch Div., Minneapolis-Honeywell Requisiter. 8 Stronderd, special Honeywell Requisiter. 6 Pp. Allis-Cholmers Mfg. Co.
 786 Phete-Sectric Control. For use where extended
 time delay is not required. Bulletin G&A-7230,
 6 pp. General Electric Co.
 786 Phete-Sectric Control. For use where extended
 time delay is not required. Bulletin G&A-7230,
 6 pp. General Electric Co.
 786 Phete-Sectric Control. For use where extended
 time delay is not required. Bulletin G&A-7230,
 6 pp. General Electric Corp.
 788 Semicenducter Preducts. Transistora, diodes,
 rectifiers, copocitors, networks. Form Tt. 1704,
 20 pp. Taxos instruments inc.
 789 El

Hydraulic, Pneumatic

- 401 Hose Counseters. 4 pp. Atlantic Metal Hose Co.
 Inc.
 408 Labricating Gresse. 32 pp. Bordohl Mfg. Corp.
 613 TFE 0-Bisss. 4 pp. Chicoso Gesket Cc.
 618 Fluid Stearing Centrel System. 8 pp. Chor-Lyan
 Co.
 420 Lubricatine Devices. 12 pp. Trico Fuse Mfg. Co.
 422 Control Velves. 8 pp. Off-Jordon.
 424 Fluid Filters. 8 pp. Resonn Filter Co.
 428 Sproy Nesztes. 4 pp. Sproying Systems Co.
 642 New Exchangers. 4 pp. Sproying Systems Co.
 643 Polid Stationagers. 4 pp. Sproying Systems Co.
 644 New Exchangers. 4 pp. Sproying Systems Co.
 647 Differential Pressure Devices. 32 pp. Industrial
 Instrument Corp.
 722 Metal Seeis.* State, specifications, materials

- for K-Seat line. 38 ps. Herrison Mfg. Co.

 733 Directional Coartel Velves." Two, three, foerway units for pressures to 3000 psi. Bulletins 80200-A, 80300-A, 22 ps. Oilgear Co.

 784 Bellews, Bellews Assemblies." For high and low-pressure liquid and passeus systems. Bulletin 611-B, 4 ps. Avica Corp.

 785 V-Band Couplings." Covers cost, weight, institution time savings over other joining methods. Booklet SDP-2, 16 pp. Marmon Div., Aero-quip Corp.

 786 Air Pawer Cyllader." Series C, 200-psi unit, in 1½ to 4½-in. bore sizes. Bulletin 0220-81, 4 pp. Hannifin Co., Div., Perker-Hannifin Corp. 58 pp. Hannifin Co., Div., Perker-Hannifin Corp. Spraying Systems Co.

 788 Passumetis, Hydraelic Packines." Covers verious types of pockings; gluss full specification data. Bulletin 241, 16 pp. Chicago-Allis Mfg. Corp.

 789 Quick-Disconnect Couplers." Open-Flow units for pressures to 600 psi. Sheet L-5104-2, 4 pp. Bruning Co.

 760 Centriuses Pumps." Spilt-case units range up to 600 spm. Bulletin 105C, 8 pp. Aurore Pump Dro, New York Air Broks Co. Inc.

 761 Ball Velves." Selection data for Econ-O-Miser units. 4 pp. Worcaster Volve Co. Inc.

 762 Gliers, Centrels, Lubricaters." Dimensions, copocities, Installation data. Circular 580, 4 pp. Lunkenheimer Co.

 763 Selecciól Valves." New two, three, four-way units. "Condensed Volve Supplement," 16 pp. Automatic Switch Co.

Mechanical Equipment

- 405 Differential Gearing. 8 pp. Strates Div., in-dustrial Products Branch, Fairchild Strates
- Corp.

 Corp.

 606 Linkspe Joints. 4 pp. Link-Ape Corp.
 609 Universal Drive Tousioner. 4 pp. Brewer Mochine & Goor Co.
 614 Conveyer-Balt Engineering. 24 pp. Hewitt-
- Robins. 421 Shaft-Mounted Reducer. 4 pp. Dodge Mfg.
- Corp. Corp. 425 Chain Lubrication, Oil-Rite Corp. 425 Chain Lubrication, Oil-Rite Corp. 547 Industries 430 Ball and Roller Bearings. 24 pp. SKF Industries

- 430 Ball and Roller Bearings. 24 pp. 3Kr impositive. Inc.
 434 Minieture Components. 18 pp. Northfield Preclain instrument Corp.,
 45 Speed Raducers. Single-reduction, right-angle,
 apiral bevel gear units. Cetalog 42C, 24 pp.
 D. Jomes Gear Mfg. Co.
 765 Minieture Gears. In precision I, II, III
 classes also clamps, shafts, plus. Cetalog 64,
 256 pp. Perfect Gear & Instrument Corp.
 764 Red Ends; Spherical Bearings. Expanded line
 of Alinobal units. Cetalog 102. 12 pp. Split
 Ballbearing Div., Minieture Precision Bearings
 Inc.

- Bollbecring Div., Minieture Precision Bearrings Inc.
 767 Verieble-Speed Belts.* Contains extensive cross-reference identification data. Bullistin 24103, 20 pp. T. B. Wood's Sons Co. 768 Jawel Bearings, Assemblies.* Properties, types of jewels and precision metal parts. 8 pp. Moser Jawel Co. 769 Slawv. Bearings and Bers.* Custom-designed and standard stock units. Bulletin JBL-35, 4 pp. Johnson Branze Co.

Assembly Components

611 Sheek Alsorbers, 20 pp. Elils Fluid Dynamics Corp.

- 770 Nux-Bead Cap Serews.* Conform to ASA Standard B-18.6.2. Form 2788, 12 pp. Cleveland Cap Serew Co.
 771 Industrial Retaining Rings.* Dimensions, engineering specifications, drowings. Catalog 61, 24 pp. Industrial Retaining Ring Co.
 772 Telerance Ring.* Definition, function, types of Ster unit. Catalog SFTR, 18 pp. Relier Baaring Co. of America.

Manufacturing Processes, Parts

- 773 Vacuum Metalliziag.* Advantages over other metal-deposition techniques. Builetin 584, 16 pp. F. J. Stokes Corp.
 774 Precision Casting.* Planar-investment and planter-mold casting. Plus a combination method.
 18 pp. Atlantic Casting & Engineering Corp.

Materials

- 604 Metal-Bruid Constructions. 4 pp. National-Standard Co.
 607 Aluminum Screw-Machine Steck. 154 pp. Aluminum Co. of America.
 610 Light Metels. 44 pp. Brooks & Perkins Inc.
 610 High-Streagth Steel. 20 pp. Vanudium-Alloys
 Steel Co.
 619 Structural Dampins. 8 pp. Lord Mfg. Co.
 623 Brasses and Tin-Brasses. 6 pp. Riverside-Alloy
 Metol Div., N. K. Porter Co. Inc.
 627 Breeze Parts. 4 pp. Johnson Bronze Co.
 629 Small-Diemeter Tubins. 18 pp. J. Bishop & Co.
 632 Wire Cloth. 16 pp. Unique Wire Weaving Co.,
 Inc.
- Inc.
 Tress Strip. 4 pp. Chase Brass & Copper Co.
 TS Magnetic Metals.* High Permeability 49 and
 HyMu 90 alloys discussed as to permeability,
 core loss. Bulletin 8-3, 40 pp. Magnetic Maria.
- 76 Egexy Preducts.* Helix bonding opents, potting compounds, seelents, cootings, occasiories. Catolog 1961, 48 pp. Carl H. Biggs Co. Inc. 777 Feem Preducts.* Properties and uses of standard from products. 12 pp. Emerson & Cumise Inc.
- 778 Tellas Bets.* New uses, new products, stand-ords material, other data; monthly. "Journal of Tellon," 8 pp. E. I. du Pont de Nemours & Co. Inc. 779 Capper-Nickel Alley.* Neutraloy fine wire for use in precision instrumentation. 4 pp. Molecu Wire Corp.

Engineering Dept. Equipment

- 616 Power Supplies. 16 pp. Valor Instruments Inc.
 638 Tampereture Tressducers. 4 pp. Trons-Sonics Inc.
 780 Strais Recordine.* Application of stroin gapes, tránsducers for recordine strain, tension, thrust, icod, torque, Form SR, 20 pp. Brush instruments Div., Clevite Corp.
 781 Profilemeter Instrumentation.* Standard line for measuring surface reughness. Catalog 161, 12 pp. Micrometrical Mis. Cs.
 782 Ceetral Equipment.* High-performence, feedback-control hardware. 6 pp. Boonshoft Fechs Inc.

NEW PARTS MATERIALS ENGINEERING EQUIPMENT

Electrical, Electronic

- 654 Terminal block accepts all common lead terminations. Modular Electronics.
 658 Lead cell is actuated by deflections as small as 0.001 to 0.005. Force Centrals Co.
 660 Synchroneus meter drives large inertial masses of constant rate of speed. Beau Electronics
- inc.

 A Printed-circuit grid boards in two new configurations. Cerning Electronic Components Div., Corning Glass Works.

 Georgia Components Div., Texas Instruments Inc., Components Div., Texas Instruments Inc., Texas Instruments Inc., See Instrument gear moter has all repediable speed ratios. Insco Ce., Div., Barry Wright Care.
- Corp.

 669 Small meters are rated ½ and ¼ hp at 2750 rpm. Small Motors Div., Robbins &
- 4649 Small meters are rated 1/5 and 1/6 hp at 2750 ram. Small Motors Div., Robbins & Myers Inc.
 470 Limit switches are two-pole units controlling up to four circuits. Square D Co.
 421 Gear meters, sear bases have ratios from 411 to over 100,0001. Spirold Div., Illinois Tool Works.
 473 Cable cannocter connects flat cable to round wire. Thomas & Betts Ca.
 4/6 Feed through cospecters are minieture units with low inductance. Hi-Q Div., Aerovax Carp.
- with low inductance. Here birty, and corp.

 Gerp.

 680 Midget lampholder for use with midgetgroove lamp. Webster Electrenics Co. Inc.

 684 Subtrectional-be mehres are explosionproof
 units from 1/150 to 1/20 hp. Noitzer-Cabot
 Motor Div., National Pecumeits Co. Inc.

 685 Stack switch for ministure electrenic equipment. Switchcraff Inc.

 689 Napantic-hold switch permits electrical reiouse from a remate location. Micro Switch
 Div., Minnegoolis-Hengywell Regulater Co.

 691 Subministure fuse for printed circuits. Littelfuse Inc.

- fuse Inc.
 695 Time-delay central develops de voltage from signals of any wave length. Victoreen In-
- signals of any wave temps,
 strument Co.

 498 Silices power translater has current coin
 of 1000 at 2 amp. Semiconductor Dept.,
 Westinghouse Electric Co.

 499 Hish-current switches in pracision, snep-actins design. Unimax Switch Div., Maxson
 ins design. ing design. Unimax Switch Div., Maxson Electronics Cerp.
 702 Pessberten centre is triple-function unit. Mackworth G. Rees Inc.
 704 Phis and societa are miniature units in over 100 configurations. Omega Precision

- over 100 configurations. Omega Precision Inc.
 1707 Lighted-headle switch incorporates neon light behind recker button. Pass & Seymour Inc.
 1709 Ceramic capaciters in values to 0.2 mfd. Centrolad-Electronics Div., Globe-Union Inc.
 1713 Subministers circuelt breakers in two and three-pole models. Halnemann Electric Co.
 1713 Centrol switch united in single, compact unit.
 1715 Printer-doucts Corp.
 1715 Printer-doucts Corp.
 1717 Epsay-sealed switch submices occommodates printed circuits measuring 0.054 to 0.071 in. Viking industries inc.
 1717 Epsay-sealed switches protect Internal mother in the compact of the control o
- 1.8 to 4460 rpm. Allis Chaimers Mfg. Co.
 277 Pestheviren timens offer wisie choice of time
 cycles. Bristel Meler Div., Vecaline Co. of
 America Inc.
 278 Germanium transisters are 0.130 x 0.130-in.
 site. Semiconductor Div., Raytheon Corp.
 279 Sia-speed drive has remote-control, pushbutton panel. Lima Electric Motor Co. Inc.
 272 Wirewound petentismeter in 10 to 30,000chm range. Atohm Electronics.
 273 Sia-sight synchros incorporate transparent end
 caps. Western Div., IMC Magnetics Corp.
 274 Fluorescent immphelder for T-5 lamps. Circle
 F Mfg. Co.

Hydraulic, Pneumatic

- Hydraulic, Pneumatic

 42 Seel-bellaws for high-temperature applications. Tube Turns Div., Chemfron Corp.

 45 Swivel filtings absorb vibration, shock, and thermal expansion. Dumant Engineering Co.

 468 Relief velves in either low or high-pressure ranges. Fluid Regulators Corp.

 471 Hydraulic pump of axial-pisten typs. Weatherhead Co.

 478 Nylan pressure tuking for temperatures from —40 to +185 F. Gorlock Inc.

 479 Geogless regulater in single or double-stage units. Dackson Corp.

 479 Compressed-air unit filters, regulates, lubrication. Williamson Corp.

 488 Ministers talescool filters provide high filtration Pall Corp.

 488 Ministers salescool valve for operating pressures to 3000 psi. Circle Seel Products Co.
- 699 Line strainers for 600 pai et 650 F or 1000 pai et 100 F. OPW-jorden.

- 694 Air-centrel valve for double-acting, 2-in. diam cylinders. Novi-Matic Valve Div., Novi Tool & Machine Co. 697 Buel-purpose seekets are RFI shield and fluid-sealing units. Technical Wire Products

- 697 Buel-purpose seakers are RFI shield and fluid-sealing units. Technical Wire Products Inc.
 703 Relief velves for pressures to 500 psl. Combination Pump Volve Ce.
 705 Air-centrel valve for air or fluid-power applications. Hoffman Valves inc.
 706 ear pump in three series with output delivery from 7 to 97 gpm. Commercial Sheoring & Stamping Ce.
 712 Braided seaking of carbon-free, white Tefion filament. Greene, Tweed & Co.
 715 Selemeid velve for pressures to 1000 psl air.
 Automatic Switch Ce.
 719 Liquid-level gages are available in six new units. Gits Brost. Mfg. Co.
 721 Pisten gump in 2 and 3-gpm sizes. Hypro Engineering Inc.
 723 Air cyllinders have up to 3-in. stroke lengths. Bimba Mfg. Co.
 724 Plactic pipe fifthings in sizes and shapes for 1/16 through 1-in. pipe. Cojon Co.
 725 Steinless-steel bell velve has high corrosion resistance. Lunkenheimer Co.
 736 Ul-level sight gages for use with fire-resistant fluids. Contury Hydraulics Div., Century-Detroit.
 731 Hydraulic cyllinder in V2 to 14-in. bore sizes.

Mechanical Equipment

- Mechanical Equipment

 650 Seamless Mylar belts for fractional and subfractional range. Kinelogic Corp.

 631 Ministerre vibratier has maximum air consumption of 6 cfm. Mortin Engineering Co.

 633 Ministerre differential in hevel-gear type.

 Washington Scientific Industries inc.

 646 Ministers flaxible coupling couples two
 shofts in absolute unison. Coupling Div.,
 Guardian Industries Inc.

 647 Overload-release clutch incorporates torque,
 selecter dial. Centric Clutch Co.

 647 Ministerse clutches operate to 1800 rpm without lubrication. Prection Specialties Inc.

 648 Gear reducer changes speeds while rototing. Anolog General Corp.

 693 Hysteresis clutch is fractional-horsepower
 unit. Scanner Corp. of America.

 700 Self-eligening bearing is three-bolt, flangemounting unit. Bronze Bearings Inc.

 701 Ceaveyer belting handles bulky, hot, or heavy
 materials. May-Fran Mfg. Co.

 714 Clutch-brake essemblies are evallable in two
 sizes. Dial Products Co.

Assembly Components

- 452 Spring fension clips retain electrical com-ponents in 0.10 to 1.12-in. diam. Birtcher Corporation/Industrial Div. 457 Extraded-duminum shide for standard or mini-giture equipment. Grant Pulley & Hordware
- 457 Extraded-aroman-drure equipment. Grant Pulley a Corp. 463 Dewel plas in sizes as small as 0.0284 x 0.21 in. Anti-Corrosive Metal Products Co. 786 Spries meantings for machinery and air-conditioning equipment. Shock & Vibration Div., Kerfund Co. Inc. 722 Meter bases automatically provide proper belt tension. Manhelm Mfg. & Belting Co.

Materials

- Materials

 453 Pawdered epexy feams can be used from

 —65 to +300 F. Emerson & Cuming Inc.

 459 Dry-castles companied has high thermal conductivity. Hysol Corp.

 478 Castles resis is self-extinguishing, two-port formulation. Emerson & Cuming Inc.

 452 Steinless-steet elley for severe cold-forming applications. Armos Steel Curp.

 453 Epexy resis is self-extinguishing in less than I sec. isochem Resins Co.

 466 Nigh-straught apaxy affective is two-component system mixed in equal parts. Rubber & Aubestos Corp.

 472 Pressure-censitive tage of polyvinyl fluoride has good electrical properties. Connecticut Hard Rubber Co.

 476 Teffue felts have good chemical resistance, high friction efficiency. American Felt Co.

 4768 Phenelic glass leminates in thicknesses from 0.125 in. Mica Corp.

Engineering Dept. Equipment

- 735 Bratting instrument for fest application of self-sticking topes. W. H. Brady Ce. 736 Ferce weekers are temperatures of 50 to 250 F. Avionics & industrial Products Div., Lockheed Electronics Co. 737 Bratting table can be adjusted to any height or onete. Unitech Cerp.

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- 738 X-Y recerder is designed for rack mounting.
 Houston Instrument Corp.
 739 Breesbeerding kit permits rapid assembly of prototypes. Precision Metal Products Ca.
 740 Saturion-metering pump measures small quantities of fluid. Scientific & Process instruments Div., Beckman Instruments Inc.
 741 Pressure cell permits precise static measurement. Kylife-Bytrex Corp.
 742 Strain indicator operates from batteries or external ac supply. Metrix Inc.
 743 Small thermaceuple in Chromel-Alumel or Iron-Constantan types. Advanced Products Ce.

EDITORIAL ARTICLES

Single copies of the following articles are available as long as the supply lasts. Starred items are from previous issues. See Page 307 for other available reprints. Editorial content of Machine Design is indexed in the Applied Science Technology Index and the Engineering Index, both available in libraries. Microfilm copies are available from University Microfilms, 313 N. First St., Ann Arbor,

- 21-1 Three Men on the Moon. Assoult on the moon: Project Apollo. (3 pp.)
 21-2 Value Resineerins. Setting up a programy pertinent recommendations. (5 pp.)
 21-3 R & D Centract. Rules for ensuring good contract relations with the government. (5
- contract relations with the government. (5 pp.)

 21-4 Cald Heading of Plastics. Results of tests made to adapt cold heading of plastics to be concerned to the control of force in hydroulic systems. (6 pp.)

 21-5 Serveralives for Force Central. Using serveralives for occurate control of force in hydroulic systems. (6 pp.)

 21-6 Central Coefficient Cabs. Design of cabs for off-the-road vehicles to provide optimum off-the-road vehicles to provide

- quickly finding critical speed of shorts. (3 pp.)

 21-11 Preparties of Thermoplastics (Abstract). Gives properties of nylon, acral resin, polycarbanate, methocrylate, ABS materials, polycathylene, polypropylene. (3 pp.)

 20-3 Gaket Leeds. Four techniques for evaluating flange pressure factors to improve flanged-joint design. (7 pp.)

 20-9 Pin-Joint Design. Namograph design procedure for matching joint proportions to aperding requirements. (4 pp.)

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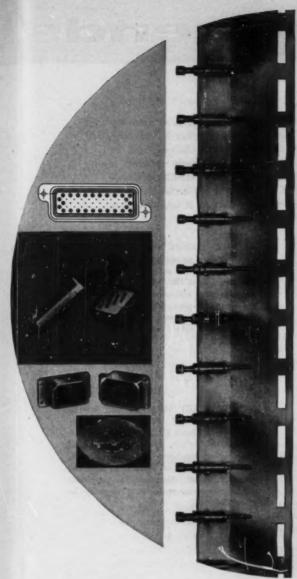
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Ram Air Ups Diesel Performance

By ramming in combustion air, Mack Truck engineers have increased volumetric efficiency of naturally aspirated diesel engines 10 per cent. They've built up intake-valve pressure by a pulse technique, and, by combining highly efficient manifolding with a fuel pump matched to the new intake rate, added 10-hp output to the END-673 engine—with virtually no increase in weight. Because of the better breathing characteristics, combustion is more complete, torque is up, and there is no smoke.

HYDRAULIC ACCUMULATORS may soon furnish the muscle for power steering, brakes, seats, convertible tops, and other automotive subsystems. According to Greer Hydraulics Inc., Los Angeles, an accumulator big enough to power all the accessories will cost less than one piece of optional power equipment on the market today. Hydraulic units are now in use in missiles, ships, and aircraft.

AN ALL-ELECTRONIC alternator system will completely replace generators on cars and trucks by the end of 1964, according to Motorola's Automotive Products Div. The Motorola system is designed for an unlimited operating life, and it will never require adjustment—there are no relays, buzzers, or contact points. Rated at 600 w, it should extend battery life by 25 to 50 per cent.

motorials

BOUNCING ROCKS may lead researchers to an elastomer that can resist 1000 F. A new rubber, formed by pulverizing rocks, breaking down the atomic particles, and combining what is left with appropriate chemicals, is under development at Aerojet-General Corp. It has already withstood long periods at 600 F without losing elasticity, burning, or disintegrating, and AGC scientists feel it can be improved.

ALUMINUM SHEET AND FOIL can now be permanently vulcanized onto rubber. According to Reynolds Metals Co., Richmond, Va., developers of the hybrid, the resulting material combines surface toughness, corrosion resistance, and insulative values of aluminum with the flexibility of rubber. Aluminum tire cords and flexible aluminum-covered tubing seem to be likely applications.

computers



Computer Quotes Latest Stock Prices

News media that are members of the Associated Press will soon be getting stock-market data from an IBM computer system. The data-processing equipment will be the first with the ability to gather stock information from four major exchanges and then transmit up-to-the-minute prices to distant points over communications lines. The equipment will provide a link in an automated flow system that will route data from stock tickers, through the computer, to tape-operated type-setting machines all over the country.

Programming Faces a Language Barrier

Computer manufacturers have perpetrated a modern "tower of babble" in computer languages, according to Dr. Edward Feigenbaum, University of California. There are now about 100 different languages, and dialects are beginning to crop up for each. Lack of some degree of standardization may be a major obstacle to the growth of computer applications. "If all the computer-programming systems that are now in progress or scheduled for development are completed, it will take 3500 man-years."

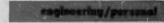
Bunched Electrons Amplify Ultrasonic Waves

A new class of solid-state electronic devices now appears possible. Ultrasonic waves have been amplified directly in a piezoelectric semi-conductor crystal at Bell Telephone Laboratories, and the combination of piezoelectricity and semiconduction seems promising for the future. According to BTL, the waves produce a periodic electric field in a piezoelectric material, and when the material happens to be a semi-conductor, the flowing electrons bunch up. The bunched electrons can then be put to work in a number of ways.



Carbon-Covered Cathodes

Electron beams with special shapes can be formed after a cathode is treated by a new carburization process that suppresses emission from portions of the surface. Developed by Philips Metalonics, Mt. Vernon, N. Y., the technique is also useful in preventing electron emission from cathode supports and from auxiliary electrodes close to the cathode. According to Philips, it is usually difficult to achieve these objectives because most metals become activated by cathode evaporation and migration products. Emission from barium-activated dispenser cathodes is reduced by up to three orders of magnitude.



Electronics Industry Chided for 'Second Placemanship'

The present philosophy of the electronics industry endangers the cornerstone of its very foundation—technical creativity. According to Dr. Arnold O. Beckman, president, Beckman Instruments Inc., the pioneering spirit may soon be killed. Business strategy leaves leadership to others; the idea is to grab new business through quick production of a cheap version of the pioneer's product. The industry, founded on basic innovation, may not be able to meet future competition.

ASTM has added an "and" to its name. Now officially titled American Society for Testing and Materials, the society has gone through the courts to ammend its charter. The new word, according to Miles N. Clair, ASTM president, "places added emphasis on the society's research work in seeking fundamental knowledge of the nature of materials."

FREE-LANCE and corporate inventors now have computer facilities at their disposal. Institute for New Products Inc. helps the inventor find a market for his brainchild by performing a critical analysis on the patent, fitting it into a 40,000-variable computer-processing system, and electronically pairing it with coded requests from firms seeking new products and ideas. NPI brings companies and inventors together; it doesn't take part in negotiations.

DEMAND FOR ENGINEERS and scientists reached the highest point of the year in August, according to the latest Index calculated by Deutsch & Shea Inc. Up 17 per cent from July, the 112.8 index is very close to last year's high of 113.9, recorded in October. And data analysis shows the rise is a general one that is not restricted to just a few areas.

NUMBER OF ENGINEERS and scientists employed by American industry is now estimated as 870,000, according to the National Science Foundation. It breaks down this way: Engineers, 80.5 per cent; chemists, 9.4; biologists, 2.4; earth scientists, 2.0; physicists, 2.0; unclassified, 3.8. In January 1959, NSF reported 800,000 employed, but in the period 1954-58 the manpower rate was increasing 13 per cent annually. Now it's down to 5 per cent.



S OMETIME before 1970, if the near-crash space schedule stays intact, three American astronauts will land on the moon. Their means of transportation is now the concern of the best brains and equipment the U. S. technical community can muster.

Project Apollo, as it now stands, is a vast composite of engineering problems that can be roughly divided into two main areas: Booster development and spacecraft design.

Saturn by 1964

Two versions of the Saturn booster, the C-1 and C-2, will do the heavy lifting during initial flights of Apollo. First stage of both Saturn versions is an eight-engine cluster of kerosene-lox engines that develops 1.5 million lb total thrust.

C-1, which will put Apollo in earth orbit, can handle a 20,000-lb space capsule. Its second stage, 17 ft in diameter and 40 ft long, will consist of six hydrogen-oxygen engines, each developing 15,000 lb of thrust. Third stage will be the powered capsule. At lift-off, the vehicle will stand about 180 ft tall, weigh 500 tons.

C-2 represents a radical advancement in hydrogen-oxygen engines. Second stage of the vehicle will use four 200,000-lb-thrust hydrogen engines being developed by Rocketdyne. It will be capable of putting 15,000 lb into a circumlunar trajectory. C-2 will stand about 209

fiven \$20 billion and eight years' time, U.S. scientists have been charged with the most immense technical program in world history. Its name: PROJECT APOLLO

ft tall at lift-off.

For the lunar-landing mission, Saturn will be replaced by the Nova booster. This vehicle will use a cluster of F-1 engines, each rated at 1.5 million lb thrust, as the first stage. With proper upper staging, including more F-1s, Nova will accelerate 70 tons to escape velocity.

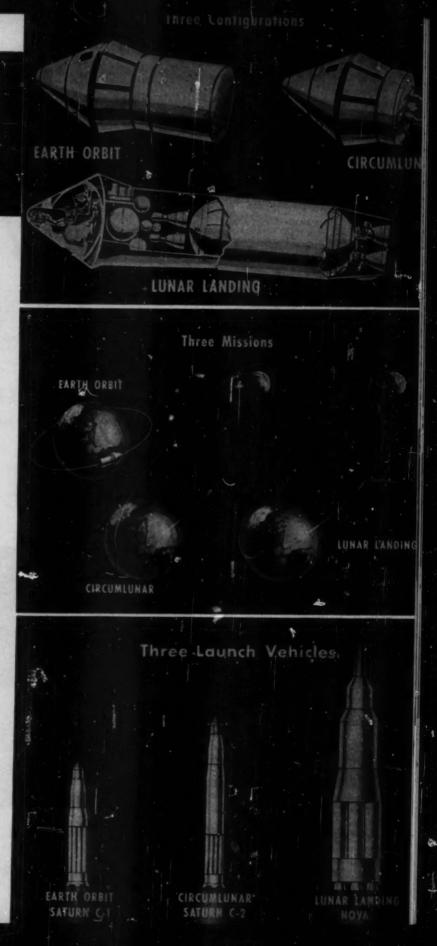
Ten launchings are scheduled in the current Saturn R&D program. The first launching, with inert upper staging, is planned for later this year. Following the tenth launching in 1964, C-1 is expected to be operational.

The kerosene-lox F-1 engine, being developed by Rocketdyne, is scheduled to be operational in 1963. This should allow adequate time for it to be incorporated into a Nova ahead of the 1970 launch deadline. As a back-up, however, NASA has allotted research and development funds to the solid-fuel industry. Spokesmen for solid fuel claim somewhat optimistically that they can have a booster equal to Nova's F-1 cluster ready by 1965.

Multimission Package

Although Apollo's ultimate purpose is lunar exploration, the spacecraft is being designed to accomplish a variety of missions. A modular concept has been settled on, which will permit the capsule to be assembled in three configurations:

Basic module will be the command center. It will probably resemble a big Mercury capsule. A second 2500-lb propulsion module will provide power for orbital maneuverability and re-entry. A third "mission" module will serve as a second room for living space, and as





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THREE MEN ON THE MOON

- a laboratory for orbital equipment. Astronauts will be able to work in a shirtsleeve environment in the mission module.
- For circumlunar missions, the command center will be coupled to a 5000-lb propulsion module.
- Lunar-landing configuration will include the basic command center, plus a sizable propulsion module. Additional power needs for lunar landing and lift-off will boost the weight of the spacecraft to many times the 15-20,000-lb limit of the orbital and circumlunar versions. Well over 100,000 lb will have to be boosted to escape velocity.

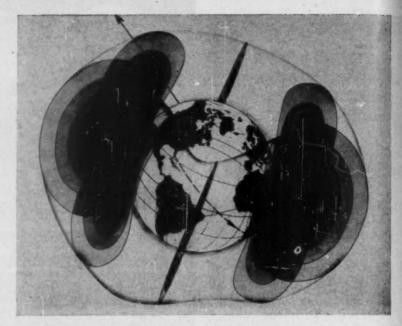
Minimum Lift

Although the exact shape of the spacecraft has not been revealed by NASA, several conclusions can be drawn, based on practical limitations.

A purely ballistic vehicle is ruled out. To decelerate and land safely in its first pass around the earth. it would have to enter a flightpath corridor no more than 7 miles wide. NASA concedes that present guidance technology could not insure this measure of exactness. If the capsule undershoots the corridor, its occupants will be destroyed by high deceleration forces, or will burn up. If the vehicle overshoots, it will take another excursion out into the great radiation belts, involving several additional days of flight, if indeed it can return to Earth at all.

NASA research on a half-cone lifting body indicates that the permissible re-entry corridor could be widened to about 40 miles. This would greatly alleviate the guidance problem and reduce accelerations imposed on the astronauts. Lift-drag ratio of the half cone will be somewhere between 0.4 and 0.7.

Any vehicle with enough lift to widen the corridor beyond 40 miles—a glider, for example—would be heavier than now seems feasible and would be subjected to fantastically high heat loads. The 18,000-mph Mercury capsule has an L/D ratio of 0.4 which is not utilized because the capsule lacks sufficient heat protection on its afterbody. In the case of Apollo, which will enter the atmosphere traveling at 25,000 mph, protection of the afterbody is still unresolved. In addition to the convective heating encountered on a



Escape frem earth will follow a polar trajectory to avoid the Van Allen radiation belts (top picture). An Apollo feasibility study at Martin Co. Indicates that the shell of the spacecraft, plus proper arrangement of equipment, can furnish adequate radiation protection. Flat water tanks will line large areas of the interior, for example. Solar flares pose an unpredictable hazard, however, one which could force Apollo to turn and run for home midway on a moon excursion. Flares only give 3-day advance warning.

Horizontal lunar landing and takeoff are being considered by NASA instead of the conventional tall-sitting approach. Weak lunar gravity, 1/6 that of Earth's, will aid takeoff, and is the one favorable element in the entire Apollo project. According to NASA, the lunar-liftoff engine will have to be the most reliable piece of equipment on the spacecraft. Countdown procedures will have to be drastically simplified over those at Cape Canaveral—only three men will be available during the moon operation.



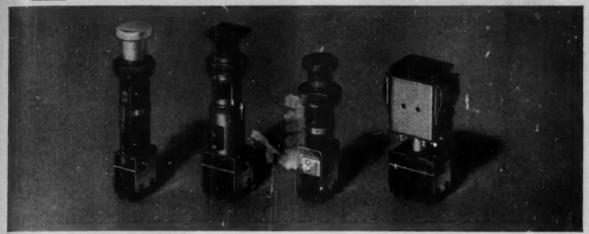
re-entering satellite, the faster Apollo will be subjected to severe radiation heating. Air behind the shock wave will reradiate a large amount of heat to the spacecraft. Charring

ablatives are one possible solution to the problem.

According to current designs, Apollo's final descent will be by parachute, ending in water impact.



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"SM" SERIES—Small size, light weight and high electrical capacity. May be assembled into auxiliary actuator brackets, gang-mounted or used in pushbutton assemblies and rotary selectors. Precise operation and long life. Also available sealed in metal housings. Write for Catalog 63.



SUBMINIATURE MERCURY SWITCH—Ideal for locations where a minimum
of operating energy is available. MICRO SWITCH manufactures over 1,000
different types of mercury switches, including enclosed models sealed in
a resilient material with a protective case to guard against shock and vibration. Write for Catalog 90.



• SEALED SUBMINIATURE—"SE" switches are available in 3 different circuit designs, with environment-free seal, corrosion-resistant aluminum housing. A smaller "XE" version now available is the smallest and lightest environment-free switch available. Write for catalog 78.



SUB-SUBMINIATURE SWITCHES—Smallest single-pole double-throw, snap-action switches available, yet have ample electrical capacity and will give long, precise service. Write for Catalog 63.

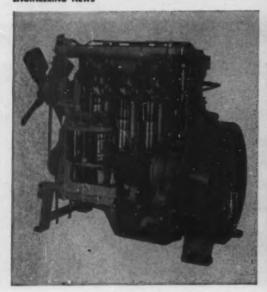
Consult the Yellow Pages for the address of the nearby MICRO SWITCH branch office, Engineering counsel is always easily available and nearby distributors simplify replacement.

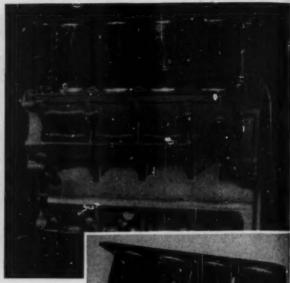
MICRO SWITCH . . . FREEPORT, ILLINOIS

A division of Honeywell In Canada: Honeywell Controls Limited, Toronto 17, Ontario



Honeywell
MICRO SWITCH Precision Switches





Power for a Wide Range of Farm Equipment...

Sleeve-and-Deck Engine

M AXIMUM parts interchangeability . . . Minimum production tooling . . . Maximum displacement in a given dimensional envelope.

These are the reasons given by a major farm-equipment manufacturer for turning to a known, but previously unused technique in

engine construction.

Deere and Co., Moline, Ill., is now manufacturing a complete line of 4 and 6-cylinder gasoline and diesel engines based on the sleeve-and-deck principle. The concept originated with Perfect Circle Corp. about 6 years ago, but never reached production. Deere's versions range from 115 to 248 cu in. in displacement; power ratings run from about 40 to 105 hp.

Design of the Deere engines is based on two integral bore versions previously in production: A 145 cu in. four and 217 cu in. six. These engines had a $4\frac{1}{2}$ in. cylinder spacing and a maximum bore size of $3\frac{3}{4}$ in., with certain foundry difficulties. With the same cylinder spacing, a $3\frac{7}{8}$ bore is obtained in sleeve-and-deck production, with the added advantage of having replaceable cylinder elements. Use of individual wet sleeves would have reduced the bore

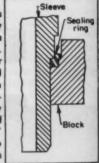
to 35/8 in. on the same cylinder spacing.

Since the cylinder bores are not part of the block castings, alloying of the block is not required. This reduces cost and improves machinability. The only difference between gasoline, LP, and diesel cylinder blocks is that diesel blocks have five and seven main bearings (4 and 6-cyl, respectively) rather than the three and four main bearings used on gasoline and LP. The close similarity is made possible by the use of a distributor-drive injection pump on the diesel engines.

Open internal construction of the block allows complete visual inspection of the casting, and eliminates any lingering doubts dur-

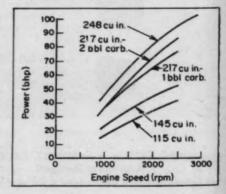
ing the inspection operation.

Sleeve-te-block seal is accomplished a imply and efficiently with a small rectangular ring. Seal is stretched over the pilot diameter and is a clearance fit with the counterbore OD, until compressed axially when the cylinder head is tightened. "Squirt" relief is provided, so that under maximum compression due to tol-



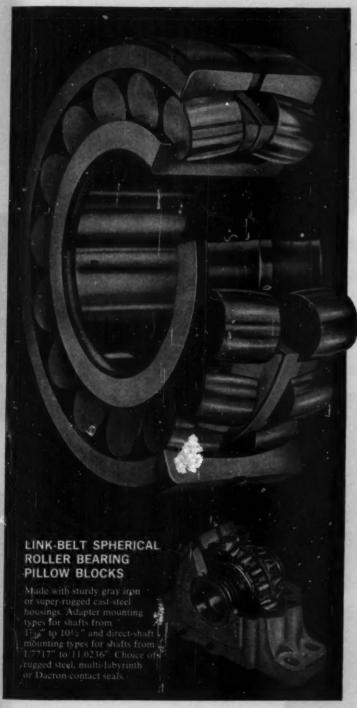
erance buildup there is minimum distortion of the sleeve.

Power curves of gasoline and LP engines (below): Values shown are at the flywheel of completely equipped engines.



LINK-BELT SPHERICAL ROLLER BEARINGS:

measure these design values in terms of your applications



GREATER CAPACITY!

The reason? More rollers, larger rollers! Bearing capacity depends primarily on effective roller Length, roller Diameter and Number of rollers (L x D x N). And Link-Belt offers the largest effective roller complement for all sizes of spherical roller bearings... rated according to accepted formulas of the Anti-Friction Bearing Manufacturers Association. This increase in LDN values provides extremely high capacity... and in users' evaluation, it adds up to far longer bearing life.

GREATER DURABILITY!

With balanced proportion design, Link-Belt spherical roller bearings possess durability characteristics that exceed the bearing industry's exacting requirements. Optimum balance of rollers, inner and outer rings must be obtained for increased bearing capacity . . . yet overall bearing dimensions must conform to an established international standard boundary plan.

Wrap-around, completely contoured retainers also contribute to durability through positive roller guidance and spacing. Precision-machined of centrifugally cast bronze, these husky retainers are far stronger than stampings or sand castings.

GREATER PRECISION!

Link-Belt spherical roller bearings are made in the world's most modern bearing plant ... with the most-advanced tools and techniques known to industry. A rigid quality control program leaves nothing to chance. Each Link-Belt bearing is subjected to 758 actual inspections. Microsmoothness and precision are continuously scrutinized by automatic machines. Result: these bearings have been specified by leading manufacturers of cranes, shovels, graders, vibrating screens, and steel mill, paper mill and foundry equipment . . and for high-precision applications such as embossing rolls, printing presses and torque converters.

SEE BOOK 2760 for further precision, durability and high-capacity features. Contact your nearest Link-Belt office. Look under BEARINGS in the Yellow Pages of your phone book.



SELF-ALIGNING BALL AND ROLLER BEARINGS

LINK-BELY COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Planas, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrichville (Sydney); Brazil, San Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World.



PICTURE REPORT

Movies on the move can be taken with a camera held steady by Veigel-Auto-Stativ, a tripod designed for mounting inside an automobile. Two suction cups, a telescopic leg, and an elastic band hold the tripod securely for taking movies or still pictures from front, back, or side windows. Position of the camera is adjustable on the platform. The tripod is made by Veigel Photogeraete GmbH, Ludwigsburg, Germany.

Temperatures to 3000 F (intermittent) or as low as — 459 F are withstood by a new paper announced by Dexter & Sons Inc., Windsor Locks, Conn. Made from quartz fibers, the paper is designed for applications such as nose-cone shielding. It can be impregnated with phenolic resin for ablation and heat-shielding applications if standard paper is unsuitable.

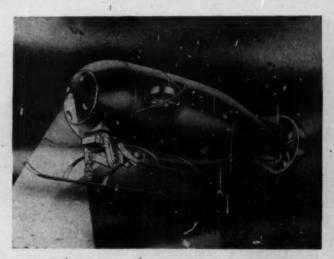




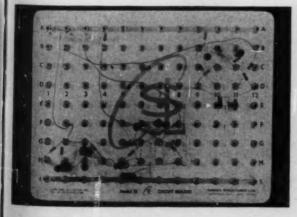
Sixty million words a day will be the capacity of COMLOGNET, the Air Force's Combat Logistics Network, being built by Western Union. The network will make possible a rapid exchange of information on aircraft, missiles, personnel, and supplies. Plans also call for handling of millions of communications concerning aircraft movements, maintenance, and passenger information. Each compound terminal—so called because it can automatically exchange messages and data in punched-card, perforated-tape, or printed-page form—will be able to exchange information with any other terminal in the system at the same time. A compound terminal consists of the four basic units shown: An IBM terminal control (left), which converts data to and from code and controls data flow; a Western Union teleprinter (center), for sending and receiving paper tape and receiving printed pages; and two modified IBM printing-card punches (right).



New British sports car, the Standard-Triumph Organization's TR4, features a high-power engine plus a number of styling changes. It has a four-cylinder, overhead-valve, 2138-cc engine (compared to the TR3's 1991-cc displacement). Compression ratio is 9:1, producing 100 bhp at 4600 rpm. It has been tested at over 110 mph and, using maximum power, gets 25 miles to the gallon. The TR4 is the first British production car with synchromesh on all four forward speeds. It is a few inches longer and wider than the TR3, comes with soft or hard top, and has safety features such as a collapsing steering column and forward-hinged hood.



Undersea research—to 6000 ft—can be carried out in the two-man Seapup VI designed by General Mills Inc., Minneapolis. The vehicle weighs only 12,600 lb, is less than 19 ft long and 8 ft wide. It is highly maneuverable in vertical, horizontal, and inclined planes. A mechanical arm performs tasks while the Seapup hovers or rests on skis on the ocean floor.



Experimental circuits are essembled, rearranged, and disassembled quickly—without the need for solder, spring clips, or jumper wires—on the Circuit Builder, developed by Circuit Structures Lab, Laguna Beach, Calif. Each of the 108 cells has an elastic rubber core which pulls out to allow the insertion of resistors, capacitors, diodes, and transistors. Seven leads of different diameters can be held firmly. The board measures 9½ by 12½ in., costs \$15.

Industrial Design

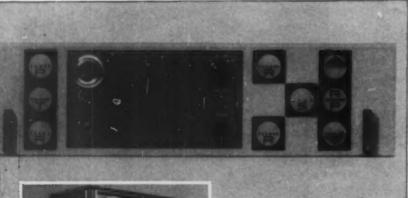
comments and configurations

Talent of America's industrial designers will come in for world-wide attention this fall. The outstanding products shown here (backed up by six more in other categories) represented the U. S. last month at an international design exhibition in Venice, Italy. The photographic display is now on tour through the capitals of Europe. A joint committee of the American Society of Industrial Designers and the Industrial Designers Institute reviewed nearly 300 entries before making its selection.



HEADPHONES

Design Consultant: J. M. Little & Associates, ASID Producer: Clevite Electronic Components



TAPE RECORDER/REPRODUCER

Designers: Frank T. Walsh, Manager Industrial Design and F. Arden Farey, Instrumentation Div., Am-

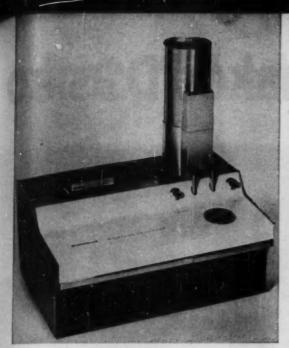
pex Corp.
Producer: Ampex Corp.





AM/FM RADIO

Designer: Bronislaw Zapolski, IDI Producer: Westinghouse Electric Corp.



GRAIN MOISTURE RECORDER

Designers: Product design staff, Latham, Tyler.

Jensen, ASID

Producer: Burrows Equipment Co.



RESERVATION KEYSET

Designer: Laird Covey, ASID

Producer: Teleregister Corp.



SLIDE PROJECTOR

Designer: Raymond A. Grosso of Harley
Earl Associates, ASID

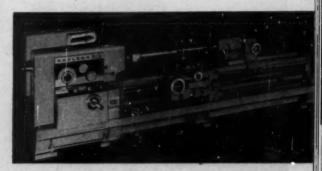
Producer: Argus Cameras Inc., Div. of Sylvania Electric Products Inc.



DESK CLOCK

Designers: Dave Chapman, FASID and Doug Anderson
of Dave Chapman Inc.

Producer: Jefferson Electric Co.



ENGINE LATHE
Design Consultant: J. M. Little & Associates, ASID
Producer: Clearing Div., U. S. Industries

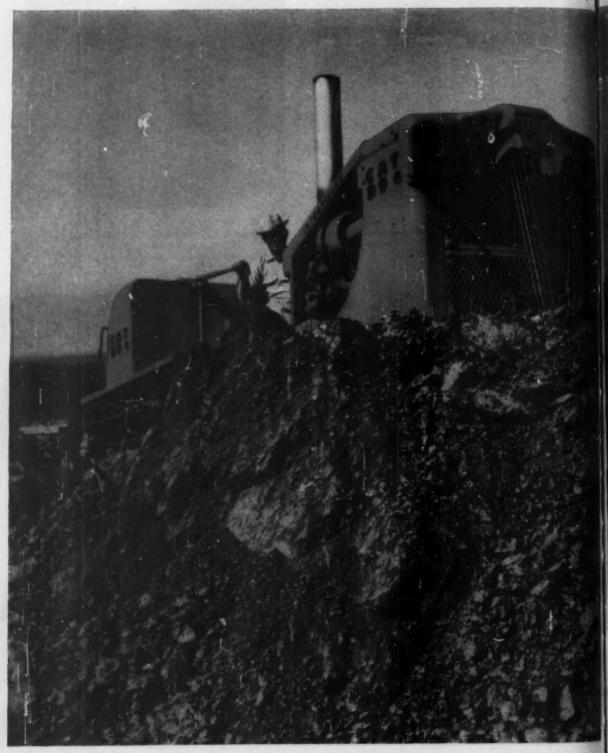


STEREOPHONIC TONE ARM

Designer: Peter Quay Yang, ASID

Producer: Gray Manufacturing Co.

What makes D9s so



strong? And last so long?

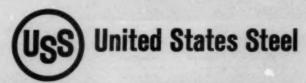


All Cat-built tractors *must* be able to take it—they lead a hard life. Especially the big, new D9G whose ferocious snarl is the result of a whopping 385 flywheel hersepower. That's an increase of 100 hp since the first D9 was introduced 5 years ago. It means that from stack to track, steel components have to be far stronger, more rugged. Solution: Caterpillar uses USS Alloy Bars for critical power train parts such as the final drive pinion. Says Caterpillar, "USS Alloy Bars meet our rigid specifications for strength, hardenability, durability, and precise tolerances."

USS Alloy Bars are not only exceptionally strong and durable, but they have excellent fabricating characteristics as well. Distortion during heat treatment and machining is an absolute minimum. USS Alloy Bars retain dimensional accuracy during quenching. And USS Alloy Bars are available in the widest range of sizes, shapes and grades in the industry. Order what you need from your nearest U. S. Steel sales office or Steel Service Center. USS is a registered trademark of United States Steel.

United States Steel Corporation • Columbia-Geneva Steel Division • Tennessee Coal and Iron Division • United States Steel Supply Division • United States Steel Export Company

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.





High-speed saw cuts USS Alloy Bars into proper lengths for finished parts.



Transmission shafts are rough ground to general tolerances before finish grinding.



Hob operation cuts teeth into shaft—precise tolerances are extremely important here.



This mark tells you a product is made of modern, dependable Steel.

the '62 cars



Thunderbird Landau Hardtop



	T-Bird			
Specifications	Standard	Optional	Standard	Optional
Bore & Stroke (in.)	4.05 x 3.78	4.05 x 3.78	3.56 x 3.62	3.56 x 3.62
Displacement (cu in.)	390	390	289	289
Compress'un Ratin	9.6:1	10.5:1	8.25:1	8.5:1
Power, max (bhp)	300 @ 4600	340 @ 5000	210 @ 4500	225 @ 4500
Torque, max (B-ft)	127 @ 2800	427 @ 3600	300 @ 2500	385 @ 3000
Carburetion	4b	three 2b	2h	46
Wheethase (in.)	113		120.5	
Length (in.)	205		204	
Whith (in.)	76		71.3	
Height (in.)	53.5		55.6	

thunderbird . . .

A TWO-SEAT sports roadster and vinylcovered hardtop are new this year for Thunderbird. They increase the line to four models, the widest selection of T-Birds since the car's introduction in 1955.

The sports roadster is actually a four-place convertible transformed into a two seater by a molded fiber-glass tonneau cover complete with padded-head rests. According to Ford, 100 engineering refinements have gone into the '62 models. Engine specifications and body dimensions are largely unchanged.

hawk . . .

STYLING is Studebaker Hawk's major emphasis for '62. The single Hawk model, called the Gran Turismo, is patterned after popular European road cars. Individual bucket seats are standard; a cupped instrument panel is fitted with aircraft-type white on black dials.

Hawk's engine specifications and body dimensions are relatively unchanged. Transmission selection includes a four-speed floor shift, automatic, three-speed manual, and overdrive.



Studebaker Gran Turismo Hawk

PATTERN

PITTSBURGH STEEL SHEET

Wrapper stock or drawn parts, flat panels or roll-formed fittings—whatever the application, Wide Pattern Designed Sheet gives finished products snap and sparkle that attract buyers, boost sales. Patterned Sheet—as wide as 60 inches, thicknesses from .0179 to .0897 inch—is available in commercial, drawing and AK drawing quality steel; has same fabricating properties as plain cold-rolled sheet in your processing equipment. Rolled-in designs—unlimited in range—take paint, enamel, porcelain, plated finishes. Investigate Wide Pattern Designed Sheet—steel with decorative appeal, from . . . PITTSBURGH STEEL COMPANY, Pittsburgh, Pa.

for other steel specialties turn page.



HOW "BOSTON" PROFITS FROM THOMAS NICKEL-COATED STRIP

Thomas Strip buffed nickel-coated steel strip reflects 40% saving, fewer production steps for C. Howard Hunt Pen Co.'s pace-setting "Boston" pencil sharpeners.

At Statesville, N.C., Hunt Pen blanks, embosses, pierces, spot-welds wrapper stock for sharpener cases from coils of 2 by .010-in. buffed nickel-coated steel. Firm has depended on Thomas Strip Division of Pittsburgh Steel Co. 20 years for brilliant finish. Purchasing Agent T. V. McCurdy tells why:

"We once used stainless for wrapper stock but costs skyrocketed. Thomas Strip costs 40% less, gives us handsome appearance, durability and easy fabrication of steel. It eliminates expense and headaches of plating, too.

"We're more critical of this material than any other—the slightest scratch stands out. We've never had to reject any during our long relationship with Thomas."

Hunt Pen produces more pencil sharpeners with nickel-plated strip than any other U.S. manufacturer. Assembly of "Champion" portable model is shown above.

Want to learn how Thomas Pre-Coated Strip Steel Specialties can help you? Ask, and we'll show you.

"WE GET BETTER PRODUCTS FOR LESS WITH THOMAS PRE-PAINTED STRIP," SAYS NATIONAL GYPSUM COMPANY

Tough, durable vinyl-enamel coat on Thomas Pre-Painted Strip fabricates easily as plain steel, gives a profitable boost to "Gold Bond" quality of National Gypsum Company's metal

building products.

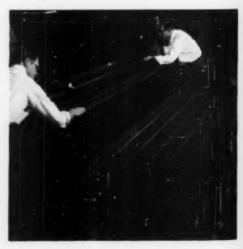
Exposed pre-finished partition bases, cornice moldings, wall trim and "J" suspension channels are roll-formed by National Gypsum Company's Niles, O., Metal Building Products plant. Coiled strip sizes range from 18 to 24 gage in widths $2\frac{1}{2}$ to $4\frac{1}{2}$ -in., painted one side with white, grey or red, and wash-coated opposite side.

Thomas Strip Pre-Painted gives us products far superior to those we got when we spraypainted after forming. It saves us 8.75 to 9.2% of production cost and reduces inventory problems," says Plant Manager D. K. Archer.

"The paint coat has better adhesion and takes roll forming without cracking or peeling. Thomas supplies us superior material of uniform, consistent quality that suits our requirements."

Photo below: roll forming 10-ft. Snap-On bases.

Eliminate your paint-line problems with Thomas Pre-Painted Strip. Let us show you how.





SQUEAKS, RATTLES SILENCED WITH THOMAS PLASTIC-COATED STRIP

Primary use of Thomas Plastic-Coated Steel is in decorative applications. But it performs a unique practical task for manufacturers of fine furniture.

Laminated to Thomas cold-rolled strip, the plastic coating assures absolutely noiseless functioning of modern, strong steel springing.

Universal Wire Spring Division of Hoover Ball & Bearing Co., Georgetown, Ky., uses Thomas Plastic-Coated Strip to make spring retainer clips that anchor its sinuous wire Uni-Torq and Uni-Flex springs to furniture frames.

"We tried applying pressure-sensitive tape to steel for this clip, but decided on Thomas Plastic-Coated. It's pre-finished and doesn't slip or peel in forming or in use," says Bernie J. Johnson, sales vice president, upholstery spring division.

"The clip acts as a pivot as well as an an-

chor for our engineered seating springs. Steel against steel produces squeaks and rattles. The plastic coating eliminates them—and makes an important sales point."

Decorative or functional — whatever the need, Thomas Steel Specialties will make your product better, too.



THOMAS STRIP HELPS "BUILD A BETTER MOUSETRAP"



World's biggest trapmaker, Animal Trap Co. of America, has the long-sought "better mouse-trap." And Thomas Strip Copper-Coated Steel helps make it so. Rattraps, too.

Animal Trap Co. of America, Lititz, Pa.,

Animal Trap Co. of America, Lititz, Pa., has depended on Thomas Strip over 25 years for close tolerance copper-coated steel strip to make bait pedals, locking bars for a dozen models.

The firm produces millions yearly from Thomas electroplated stock in sizes from .4375 by .025-in. to 5 by .035-in., #2 temper. Precise tolerances, consistent temper of base steel allow long, trouble-free runs through progressive dies, automated assembly lines.

"Base steel gives strength, economy—the planished copper finish provides appearance and corrosion resistance needed to out-sell cheap foreign-made traps," says Sales Vice President D. S. Morrison.

Want the world to beat a path to your product's door? Thomas Strip plain or coated steel specialties may be what you need. Ask.



BRASS-COATED THOMAS STRIP SAVES FOLDING-RULE MAKER 60% IN METAL COST

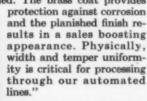
Thomas Strip Brass-Coated steel measures up to strict cost, tolerance, strength and appearance standards for Evans Rule Co. of Elizabeth, N.J., leading producer of measuring rules and tapes.

An improved type of wood folding ruleassembled with 11 patented spring joints, fabricated from Thomas electro brass-coated strip-is produced for Evans by a subsidiary -Fabrule Co.—in a fully automated plant.

For rule joints, Evans buys two sizes of Thomas brass-coated strip-1.812 and 1.562 in. wide by .012-in. thick, #3 temper, planished and oiled.

"Brass-coated strip saves us about 60% over what we'd pay for pure brass for rule joints," says John J. Evans, board chairman.

Besides that, the base steel supplies strength to take abuse, as well as rigidity needed when the rule is opened. The brass coat provides



Do expensive metals hike your product cost? Inquire how Thomas Strip pre-coated steel can help you save.



The STEELMARK on a product tells you it is made of steel. Look for it when you buy.



NEW-BRUSH PATTERN DESIGN FOR THOMAS PRE-COATED STEEL

Here's a brand new addition to Thomas Strip Division's wide range of pre-coated and pattern designed finishes for decorative applications.

Called "Brush Pattern Design," this new Thomas Strip specialty reduces finishing costs. enhances sales appeal through its deep, lustrous, textured and buffed surface-offers products attractive "plus" that influences buying decision, moves items off the shelf.

Brush Pattern Design" is cold-rolled strip electroplated with copper, brass, nickel or zinc coating, buffed to soft highlighted finish,

protected by clear lacquer.

New Thomas Strip technique produces Brush Pattern Design Strip with uniform. nontarnishing plated coating across entire surface. Fabricates easily, without distortion of pattern finish.

Reduce your product's finishing costs, improve its appearance with Thomas Brush Pattern Design. Thomas experience, design help is yours for the asking. Call or write.



THOMAS STRIP DIVISION PITTSBURGH STEEL COMPANY

Grant Building · Pittsburgh 30, Pennsylvania



Chicago Cleveland Dallas Dayton

Detroit Houston Los Angeles

DISTRICT SALES OFFICES

Philadelphia Pittsburgh Tuisa New York Warren, Ohio



Needle-Sharp Beams Will Come from Haystack Hill

The world's largest radome, a 150-ft diam aluminum and glass-fiber sphere, has been built on Haystack Hill, Tyngsboro, Mass., to house a 120-ft diam research antenna. The antenna will be the most precise structure of its kind ever attempted in this size. To be used for communications and space studies, it will have to concentrate transmitter power into sharp, high-intensity beams and provide an equally sharp receiving bandwidth. Designed by Lincoln Laboratory of Massachusetts Institute of Technology, the radome was built for the Air Force (Electronic Systems Div.) by H. I. Thompson Fiber Glass Co., Long Beach, Calif. The antenna is being built by North American Aviation's Columbus, Ohio, division. It is scheduled to be operational by the end of next year.

Meetings and Shows

Oct. 15-20-

American Institute of Electrical Engineers. Fall General Meeting to be held at the Statler-Hilton Hotel, Detroit. Further information is available from AIEE headquarters, 345 E. 47th St., New York 17, N. Y.

Oct. 19-20 -

National Conference on Industrial Hydraulics to be held at the Sherman Hotel, Chicago. Additional information is available from Illinois Institute of Technology, 35 W. 33rd St., Technology Center, Chicago 16, Ill.

Oct. 19-21-

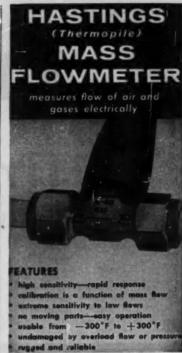
National Society of Professional Engineers. Fall Meeting to be held at the Hotel Roanoke, Roanoke, Va. Further information can be obtained from NSPE, 2029 K St. N.W., Washington 6, D. C.

Oct. 23-24-

Institute of the Aerospace Sciences. Joint Meeting to be held with the Canadian Aeronautical Institute at Ottawa, Canada. Additional data is available from IAS, 2 E. 64th St., New York 21, N. Y.

Oct. 23-25-

National Fluid Power Association, Fall Meeting to be held at the Sheraton Hotel, Philadelphia. Additional information can be obtained from NFPA headquarters.



The Hastings Mass Flowmeter consists of an indicator with power supply and a remotely located flow tube which can be installed directly in the line wherever desired. The flow tube incorporates the Hastings patented heated thermopile which is compensated for temperature and rate of change of temperature.

The Thermopile senses mass flow through the tube and produces an electrical output proportional to the mass flow which is indicated on the readout device. All flow tubes are identical and may be interchanged without recalibration of indicator.

The Hastings Mass Flowmeter is available for measurement in

RANGES 1) 0-300 Std. cc/min.

- 2) 100-1000 Std. cc/min. 3) 300-3000 Std. cc/min.
- 3) 300-3000 Std. cc/min. 4) 1000-10,000 Std. cc/min.
- 5) 3000-30,000 Std. cc/min.



For more detailed information send for specification sheet 501. For information on Hastings complete line of Vacuum instruments send for catalog no. 300.

HASTINGS-RAYDIST, Inc.

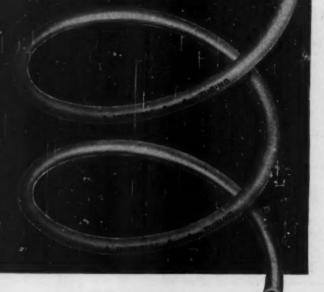
Circle 218 on Page 19

new Impolene

stabilized polypropylene

tubing

- 30 to 50 times the life of nylon at high temperatures
- 30% lower cost than nylon
- 2 to 3 times the tensile strength of polyethylene
- withstands 3 to 4 times the working pressure of polyethylene



The introduction of Impolene thermoplastic tubing foretells major improvements in the transmission of air and fluids. This Imperial-Eastman stabilized polypropylene tubing now has many proved uses. Many more await it. What's yours? For complete data, write for Impolene Bulletin No. 301.

IMPOLENE

IMPERIAL

EASTMAN

6300 West Howard Street, Chicago 42, Illinol

in Canada: Imperial-Eastman Corporation (Canada) Ltd., P.O. Bax 645, Barris, Ontario

new

with new advantages, many new uses

High tensile strength. Highest strength-to-weight ratio of all thermoplastic tubing. Working pressures compare favorably with nylon—are 3 to 4 times greater than polyethylene.

Excellent corrosion-resistance. Resists concentrated hydrochloric acid up to the boiling point. Withstands saline solutions at temperatures over 212° F. Shows no detrimental effects in boiling sulfuric acid.

Wide temperature range. Can be used up to 300° F. Has 30 to 50 times the life of nylon at elevated temperatures. Remains flexible at -100° F.

Good abrasion-resistance. High surface hardness gives it much better abrasion-resistance than most thermoplastics.

Odorless...tasteless...resists sunlight. Approved by the FDA and NSF for food and drinking water applications.

Use impolene tubing for air lines, control panels, instrumentation and lubrication systems, processing and construction machinery—many other uses.

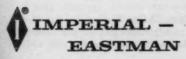
Available in 500' to 1000' spools in O.D. from %" to %". Other sizes available on special order.

Poly-Fio Fittings—designed for use with all plastic tubing, yet usable with soft metal tubing. Withstand pressures beyond burst strength of tubing. Available in a complete range of sizes and styles.



Now Imperial-Eastman meets all your requirements for hydraulic-pneumatic-flow system components: tube fittings, valves, couplings, flexible and rigid hydraulic and pneumatic lines, thermoplastic tubing, tubing tools.

TUBING



5595 N. Hollywood Ave., Milwaukee, Wis.

Oct. 23-27-

American Society for Metals. 43rd National Metal Congress and Exposition to be held at Cobo Hall, Detroit. Further information can be obtained from ASM headquarters, Metals Park, Novelty, Ohio.

Oct. 26-27-

American Society of Tool and Manufacturing Engineers. Semiannual Meeting to be held in Toronto, Canada. Additional information is available from society headquarters, 10700 Puritan Ave., Detroit 38, Mich.

Oct. 29-31-

Fluid Controls Institute Inc. Fall Meeting to be held at the Hotel Hershey, Hershey, Pa. Further information can be obtained from the institute, P. O. Box 667, Pompano Beach, Fla.

Oct. 29-Nov. 1-

American Gear Manufacturers
Association. Semiannual Meeting
to be held at the Edgewater-Beach
Hotel, Chicago. Further information can be obtained from AGMA
headquarters, 1 Thomas Circle,
Washington 5, D. C.

Oct. 30-31-

Institute of Radio Engineers— Electronic Industries Association. Radio Fall Meetings to be held at the Hotel Syracuse, Syracuse, N. Y. Additional information is available from IRE headquarters, 1 E. 79th St., New York 21, N. Y.

Nov. 1-3-

Society for Experimental Stress Analysis. First International Congress on Experimental Mechanics to be held at the Hotel New Yorker, New York. Papers will cover experimental stress analysis and other areas of experimental mechanics, and there will be a display of latest equipment and instrumentation used in the field. Additional information can be obtained from SESA headquarters, 21 Bridge Square, Westport, Conn.

Nov. 6-8-

American Documentation Institute. Annual Convention to be held at the Somerset Hotel, Boston. Further information is available from P. D. Vachon, Literature Physicist, Melpar Inc., Applied Science Div., 11 Galen St., Watertown 72, Mass.

Nov. 6-10-

American Nuclear Society. Annual Meeting, to be held in conjunction with the Atomic Industrial Forum, AtomFair, and the National Youth Conference on the Atom at the Conrad Hilton Hotel, Chicago. Additional information can be obtained from society headquarters, 86 E. Randolph St., Chicago 1, Ill.

Nov. 7-10-

Packaging Machinery Manufacturers Institute Show to be held at Cobo Hall, Detroit. The Conference-Workshop will be held Nov. 8 and 9. Further information is available from the show manager, Shea Expositions Corp., 1 Gateway Center, Pittsburgh 22, Pa.

Nov. 9-10-

Society of Automotive Engineers Inc. Fuels and Lubricants Meeting to be held at the Shamrock Hotel, Houston, Texas. Further information can be obtained from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Nov. 13-15—

Steel Founders' Society of Amer-



"Get wise, Wilkins! We're not trying to make it foolproof."



Made of DuPont Teflon

This seal is built to handle the most corrosive services. It will stand up under all conditions of acids and salts, oxidizing agents and organic compounds.

It is so designed that all parts that normally contact the fluid are made of chemically-inert DuPont Teflon. Also, for this same reason it can be operated over wide temperature range up to 250° F.

Mechanically, its bellows type construction readily adapts it for use in all non-abrasive slurry applications. It also compensates for extreme shaft run out.

Available in single face construction for internal or external mounting, double face for internal mounting.

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Extremely Corrosive Service
INCAMICAL PACKINGS

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ENGINEERING NEWS

ica. Technical and Operating Conference to be held at the Hotel Carter, Cleveland. Additional information is available from society headquarters, 606 Terminal Tower, Cleveland 13, Ohio.

Nov. 13-16-

Seventh Annual International Conference on Magnetism and Magnetic Materials to be held at the Westward Ho Hotel, Phoenix. Sponsors are American Institute of Electrical Engineers and American Institute of Physics, in co-operation with the Office of Naval Research, Institute of Radio Engineers, and Metallurgical Society of the AIME. Further information is available from Dr. P. B. Myers, Motorola Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.

Nov. 15-17-

Aerospace Electrical Society. Annual Display to be held at the Pan Pacific Auditorium, Los Angeles. Additional information is available from Norman Lynn, 1830 W. Olympic Blvd., Los Angeles 6, Calif.

Nov. 15-18-

Society of Naval Architects and Marine Engineers. Annual Meeting to be held at the Waldorf-Astoria Hotel, New York. Further information is available from SNAME headquarters, 74 Trinity Place, New York 6, N. Y.

Nov. 16-

National Electrical Manufacturers Association, 35th Annual Meeting to be held at the Plaza Hotel, New York. Further information can be obtained from NEMA headquarers, 155 E. 44th St., New York 17. N. Y.

Nov. 26-Dec. 1-

American Society of Mechanical Engineers. Winter Annual Meeting to be held at the Statler Hilton Hotel, New York. Additional information can be obtained from Meetings Dept., ASME, 345 E. 47th St., New York 17, N. Y.

Nov. 27-Dec. 1-

28th Exposition of the Chemical Industries to be held at the Coliseum, New York. Additional information can be obtained from the exposition manager, E. K. Stevens, International Expositions Co., 480 Lexington Ave., New York 17, N. Y.

Short Courses and Symposia

Oct. 28-

First National Symposium of the Industrial Designers Institute to be held at the Somerset Hotel, Boston. Theme of the symposium is "The Pivoting Forces"; its aim is to explore, in part, the relationship between the work of the designer and the needs of the forces of freedom. Additional information is available from E. Betty Berry, Executive Secretary, Industrial Designers Institute, 441 Madison Ave., New York 22, N. Y.

Oct. 29-31-

International Symposium on Photoelasticity to be held at the Illinois Institute of Technology. Sponsors are IIT, four government and military groups, and five technical societies. Twenty papers will be presented on topics including photoelasticity, photoplasticity, photoelasticity, photoplasticity, dynamic photoelasticity, and special equipment. Additional data can be obtained from M. M. Frocht, Research Professor of Mechanics, Illinois Institute of Technology, Chicago 16, Ill.

Oct. 31-Nov. 10-

Engineering Institute on the Economic Control of Product Quality to be held at the University of Wisconsin. Topics include principles of statistical quality control; construction, use, and analysis of control charts; acceptance sampling; a sequential sampling plan for verifying punch cards; and quality control attitude. Additional information can be obtained from Engineering Institutes, 3030 Stadium, University of Wisconsin, Madison 6, Wis.

Nov. 3-4-

Tenth Annual Instrumentation Conference to be held at Louisiana Polytechnic Institute. Developments in the field of instrumentation and





The Design Engineer will recognize this material—Flexible Wire Cloth—as one which has solved many problems in many types of process equipment—as a belt, screen, mold, filter or perhaps a curtain. Frequently it is a combination of these.

The fact that Audubon can create this flexible material—this material called Motalwove—with many unique qualities—to resist heat and cold, to be dense or light, tight or open—or—what's your problem?

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Richmond Street and Castor Avenue
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See us at the Detroit Metal Show, October 23 to 27, booth 633,

its applications to process control will be covered. Further information can be obtained from School of Engineering, Louisiana Polytechnic Institute, P. O. Box 255, Tech Station, Ruston, La.

Nov. 6-17-

Short Course on Bearing Technology to be heid at the University of California. Additional information is available from Sam Houston, Engineering Extension, Room 6266 Engineering Bldg. II, University of California, Los Angeles 24, Calif.

Nov. 13-16-

Research Symposium on Electrical Contacts to be held at Pennsylvania State University. Additional information is available from Conference Center, Pennsylvania State University, University Park, Pa.

Nov. 14-15-

Industrial Engineering Seminar to be held at the University of Wisconsin. Further information is available from Engineering Institutes, 3030 Stadium, University of Wisconsin, Madison 6, Wis.

Nov. 14-15-

National Society of Aerospace Material and Process Engineers Symposium to be held at the Biltmore Hotel, Dayton, Ohio. Subjects to be covered are ceramics and composites, coatings, and solid bodies. Further information is available from SAMPE headquarters, P. O. Box 613, Azusa, Calif.



"Come on boys—who sealed Mr. Purdy in the space capsule?"



measured to less than 0.1%

at temperatures from -85°F to 185°F

WHAT TYPE OF PRODUCT REQUIRES SUCH SPRING ACCURACY?

The heart of a precision aircraft altimeter contains a diaphragm and a single torsion spring. Specifications of the spring call for the rate to be constant within 0.1% over the entire deflection range and at all temperatures between -85°F and 185°F; hysteresis must be below 0.03%; and no measurable creep can be tolerated in 72 hours at maximum deflection and maximum test temperature.

HOW PROOF OF ACCURACY WAS DETERMINED

Because no equipment was commercially available to measure torsion springs to this extreme accuracy, A.S.C. Research and Development Center shared with the customer the cost of developing a special tester. Each spring is rotated in hot and cold liquid while its torque is balanced against a precision torque wire. Sightings of deflection through a transit, connected with the torque wire, are made on a scale mounted 14 feet distant. Data obtained from this unique apparatus give the spring user proof that each lot of springs falls safely within his ultra-precise limits.

Subsequently, the equipment has been used to calibrate several other torsion springs with ultra-precise specifications.

While your springs and spring-like parts may not require such precision, here is ample assurance that A.S.C. can make your springs with predictable performance in the degree desired.

May we discuss your needs?

Broad treatment of the subject of spring reliability is contained in a recent issue of A.S.C.'s house organ, The Mainspring. Send for your copy.





Altimeter instrument spring is so cured in tank fixture ready for tes ing under simulated operating cor



Spring is rotated in hot or sub-zer liquid and its torque balanced agains a calibrated wire



Minute changes in deflection ar read through a transit on a scale 1

Associated Spring Corporation

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y. F. N. Manross and Sons Division, Bristol, Conn. **Dunbar Brothers Division, Bristol, Conn.** Wallace Barnes Steel Division, Bristol, Conn. Merchandise Division, Corry, Penna.

Raymond Manufacturing Division, Corry, Penna. Cleveland Sales Office, Cleveland, Ohio Chicago Sales Office, Chicago 46, III. Ohio Division, Dayton, Ohio

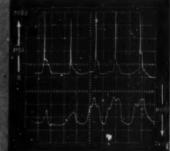
B-G-R Division, Plymouth and Ann Arbor, Mich. Gibson Division, Mattoon, III. Milwaukee Division, Milwaukee, Wis. Seaboard Pacific Division, Gardena, Calif. Wallace Barnes Co., Ltd., Hamilton, Ont. and Montreal, Que.

General Offices: Bristol, Connecticut

Circle 223 on Page 19

Hydraulic system pressure

Engine speed



Displayed on Tektronix Dual-Beam Oscilloscope



ere is one way in which an oscilloscope can be used to solve a mechanical problem . . .

In evaluating a pilot model of a 2500-poundcapacity Lift Truck, HYSTER COMPANY Proving-Ground Engineers wanted to

monitor pressure surges in the hydraulic system against a standard of engine speed.

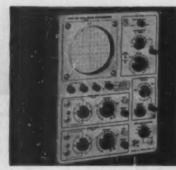
To observe both actions simultaneously, they incorporated a Tektronix Type 502 Dual-Beam Oscilloscope in a specially-designed, precision-measurement field console.

Using strain-gage techniques in testing the oil lines of the hydraulic system, the Proving-Ground Engineers were able to display and measure precise changes occurring during lifting and lowering under various load conditions.

For your own mechanical applications—in displaying information from strain gages, accelerometers, thermocouples, pressure transducers, differential transformers, similar devices—or your medical applications or laboratory applications demanding dual-beam displays on linear time bases at high sensitivity...or dual-beam X-Y displays at medium sensitivity...or single-beam X-Y displays at high sensitivity... please consider a Tektronix Type 502 Dual-Beam Oscilloscope.



photographed at HYSTER COMPANY PROVING GROUND, Portland, Oregon



Type 502 performence characteristics include: calibrated vertical sensitivity in 16 steps from 200 µv/cm to 20 v/cm, both beams, calibrated sweep range in 21 rates from 1 µsec/cm to 5 sec/cm, constant input Impedance and differential input at all sensitivities. Other Tektronix leatures include: flexible trigger facilities, 2X, 5X, 10X, or 20X sweep magnification, amplitude calibrator, electronically-regulated power supplies.



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AVISUN

announces world's biggest polypropylene plant now in production



100 million lb/yr capacity assures ample supplies of polypropylene for the fast-growing number of users

This giant new plant at New Castle, Del., establishes AviSun more firmly than ever as the industry's leading polypropylene supplier. It incorporates the most advanced manufacturing techniques—continuous processing—meticulous quality control—to produce polypropylene polymers of top quality and dependable uniformity. The polymers include a broad new range of impact grades, pipe grades and other specialty resins for fiber—and wrapping film in varying mil thicknesses.

From this great new facility will come the materials for strong, light, low-cost products of every description to meet the needs of home and industry.

And AviSun stands ready with technical assistance. Fully

equipped Customer Service laboratories—specialists with a broad and diversified background of experience in application problems—are at your service.

So plan now to explore the advantages of manufacturing or packaging with AviSun polypropylene. Complete technical data on AviSun polymer and film will be sent on request.

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OLEFORM*



a new, unusually low-cost thermoplastic now available for experimental testing...

Featuring—Unusual toughness and rigidity ● High heat resistance ● Excellent chemical resistance ● Low moisture absorption ● Good electrical insulation qualities

In rigidity and toughness Oleform compares favorably with thermosetting materials in many applications. And its improved creep resistance and mold shrinkage factors excel those of polyolefins. It can be injection molded satisfactorily, thus permitting faster mold cycles than for compression molded thermosetting materials. Its electrical insulation properties compare well with those of thermosets. And unlike thermosets, its molding scrap is reuseable.

Oleform is available in a blue-gray molding grade in experimental quantities. AviSun technical specialists stand ready to assist you in any developmental work. For full details, fill in and mail coursen today.



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Name	Title
DEPARTMENT OF	TECHNOLOGY

In Canada: Courtaulds Plastics Canada, Ltd.

Propertie: ASTM Olefern Astal Nylos 88 Filled Fland Flan			PARIS	,,,,		
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10 ³ pal 10 ³	Mechanical ^a					
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1264 pai 205 212 150-170 275 2	Heat Distortion Temp., °F	D648				
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Cents/cu in 1.5 3.3 4.0 1.2						
	Cents/cu in		1.5	3.3	4.0	1.2

- Injection molded specimens at room temperature
- Crosshead speed 1/min
- c Cresshoad speed 0.2/min
- 4 Crosshead speed 0.05/mis

announces new polypropylene 0.51pipe grade resii

• Easy fabrication • Easy welding and joining • Light weight . Low cost . High heat resistance . High chemical resistance Low friction loss Approved for potable water use by National Sanitation Foundation

In an important advance stemming from extensive research, AviSun introduces the first high molecular weight polypropylene pipe grade resin combining low cost with excellent properties. It has been broadly tested with highly satisfactory results. AviSun pipe grade resin can be processed in most conventional plastic extrudersat rates equal to or greater than that of linear polyethylene. Its high per-pound yield makes it one of the most economical plastics.

Because of the attractive properties, pipe from this resin should yield optimum performance in such applications as: salt water disposal lines; gas gathering and distribution systems; crude oil flow lines; conduit; municipal

water systems; process lines for organic and inorganic chemicals; automotive and aircraft tubing, and many others. For more data on AviSun polypropylene 1051 pipe grade resin, fill in coupon.

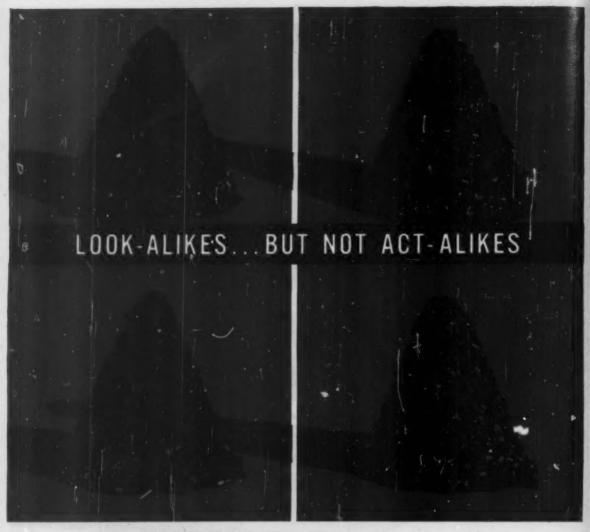


AviSun Corporation, Dept. 609 1345 Chestnut St., Philadelphia, Pa.

Send me complete data on new 1051 pipe grade resin.

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In Canada: Courtaulds Plastics Canada, Ltd.



AVISUN announces four new impact grades of polypropylene

Here, for the first time, are new impact grades of polypropylene—all possessing a translucent white resin color—with flow rates suitable not only for injection molding, but also for sheet extrusion, vacuum forming and blow molding. All four retain desirable properties characteristic of general purpose polypropylene—lightness, low cost, high heat and chemical resistance. But each grade offers a step-up in impact strength at room temperatures. Equally important, most of this strength is retained at lower temperatures—in the case of High Impact Grade 3210, as low as 10°F.

AviSun technical specialists can help if you plan to use a new AviSun impact grade of polypropylene for your product. For full technical data or counsel, write to us.

SPECIAL PROPERTIES

Property	Impact Grade 3116	Impact Grade 3216	High Impact Grade 3211	High Impact Grade 3210
Izod Impact Notched—ft-lb/in Unnotched	1.5 over 16	2.0 over 16	10 over 16	15 over 16
Flow rate—gm/10 min (nominal)	5.0	5.0	0.7	0.5
Type of molding	injection	injection	sheet extrusion vacuum forming	blow

AVISUN CORPORATION

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In Canada: Courtaulds Plastics Canada, Ltd.

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AVISUN polypropylene self-hinge won't break!

Motorola chose AviSun polypropylene for the cases of their transistor radios for these good reasons:

UNIQUE FLEXIBILITY. Self-hinge characteristic is new in the plastics field . . . can be used to cut costs, speed assembly, improve designs on a wide range of cases, boxes, and receptacles.

HEAT RESISTANCE. Polypropylene will not soften or lose strength, even at temperatures close to 220°F.

TOUGHNESS. Has the resiliency to absorb dropping and rough handling without chipping, cracking, or breaking.

ECONOMY. Polypropylene, lightest of all plastics, gives high yield per pound. Takes texture, detail and speaker vents beautifully.

The same advantages that make polypropylene the choice for transistor radio cases can benefit you in your

product. Call on AviSunfor complete data on resin grades and for expert technical assistance.



Mail coupon for technical information

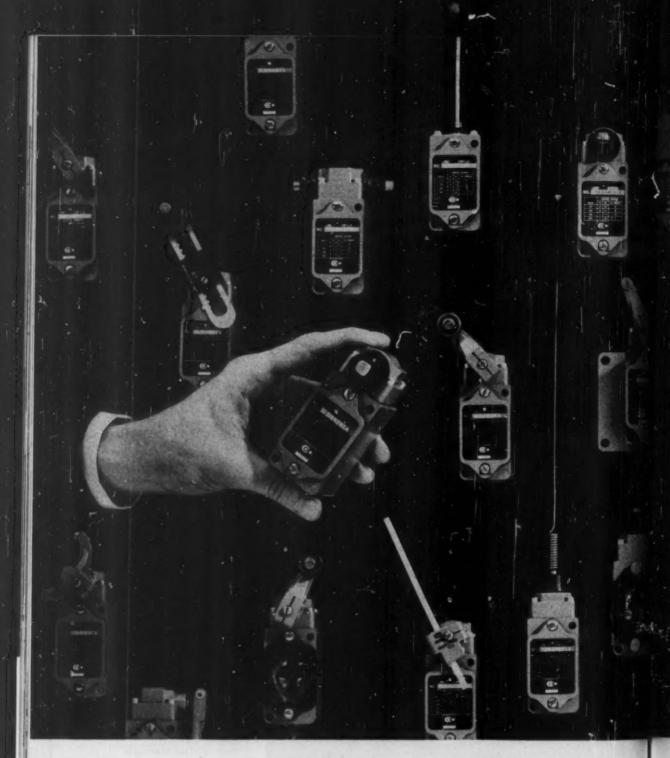
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Send me Booklet AP-601 giving full technical Information on AviSun Polypropylene.

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What's your problem? If you can solve it with a

New Cutler-Hammer operator options provide top flexibility... world's best oiltight limit switch

For any use, anywhere, in any position . . . you just can't buy a more reliable, longer-life switch. No other switch is sealed more effectively . . . effectiveness we've proved under test conditions so rugged they will never be equaled in actual service. Even the silver-to-silver contacts are visible for quick in-

spection. For full details on this complete new line, write for Pub. ED-145-U243.

For any electrical control problem, contact your local Cutler-Hammer sales office or distributor. They'll supply you with the finest electrical components, the finest service and technical help.



limit switch, your best answer's here!

WHAT'S NEW? ASK ...

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Cutter-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutter-Hammer International, C. A. • Associates: Cutter-Hammer Canada, Ltd.; Cutter-Hammer Mexicana, S. A.





We wanted nickel-chromium ingots rolled to foil .0005" ± .00005" thick with a width of .188" ± .001" x coil, with a breaking load of 7 to 9 lbs., and a blemish-free mirror finish. Hamilton did it for us.

says T. J. Scanlon, Purchasing Agent, Electron Tube Division Radio Corporation of America, Harrison, New Jersey

PRECISION IS OUR PROVINCE. Working to minimum thickness of .00008", minimum widths of ½", Hamilton can supply you with foil or strip...rod or wire ... of virtually any alloy in production quantities. Our full-scale, completely-integrated facilities and engineering talent in this field permit absolute quality control from melt to finish. Thanks to these capabilities... a familiarity with precision work inherited from Hamilton's watchmaking background... experience with ultra-thin foils unmatched

anywhere in the world . . . we offer you precision metals to meet your exact property and delivery requirements. We guarantee our product. Call us.



For additional information on Hamilton's facilities and capabilities, send for free booklet, "Precision Metallurgical Services." Write Dept. 3410, Metals and Electronics Div., Hamilton Watch Co., Lancaster, Penna.

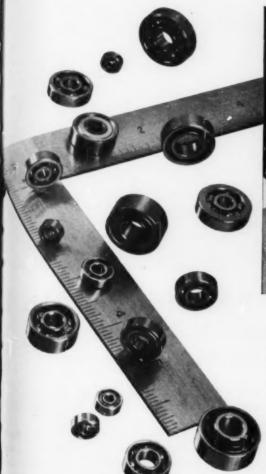
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Look to

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for leadership in ball bearings





... Space-saving ball bearings for compact power tools

Power tool makers pack king-size muscle into hand-size heavy-duty drills! Fafnir Extra-Small Ball Bearings help turn the trick. Developed by Fafnir, these bearings are engineered with deeper, smoother honed races and larger balls — to package more brawn in smaller space. Look to Fafnir for leadership in ball bearings. The Fafnir Bearing Company, New Britain, Connecticut.

50 YEARS OF EXPERIENCE IN THE MANUFACTURE OF BALL BEARINGS FAFRINGS BALL BEARINGS







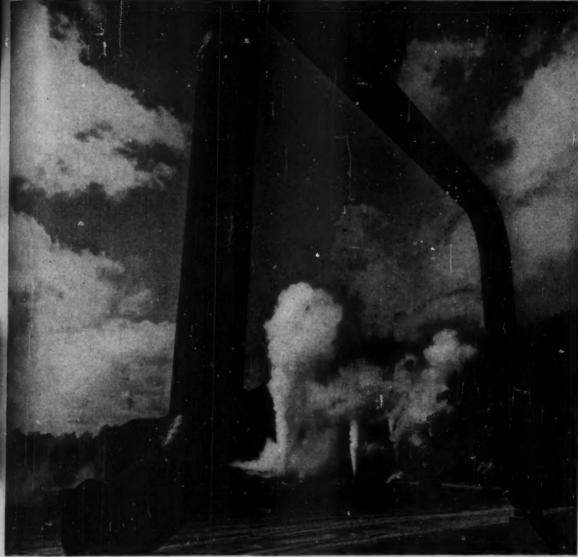
New nuclear-powered Polaris submarine, the USS Robert E. Lee, uses Fafnir Super-Quiet Ball Bearings. These specially honed bearings are the product of 23 years of Fafnir "quiet room" research and advanced finishing techniques. Look to Fafnir for leadership in ball bearings. The Fafnir Bearing Company, New Britain, Connecticut.



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This stamp on a Fafnir Ball Bearing means finest quality and workmanship . . . dependable supply . . competent engineering help . . and responsibility in meeting your bearing needs. It's worth bearing

FAFRIR BALL BEARINGS



These "geysers" actually consist of steam rocketing up from deep in the ground. From this well area, operated by Magma

and Thermal Power Companies, steam is conducted by pipeline to The Geysers Power Plant a quarter-mile away.

Now...electric power from geysers!

Nickel in stainless steel helps make possible America's first geothermal power plant.

Here's a power plant under construction in California that will produce enough electricity for a town of 50,000 people—all from the steam of meysers.

To withstand the continuous attack of this highly corrosive steam at The Geysers Power Plant, Pacific Gas and Electric Company selected stainless steel with nickel for all points where condensed steam con-

With nickel in it, stainless steel is more than a match for this corrosive team. This ability plays a key role turning out power every day of the year, with virtually no maintenance in a plant designed for unattended operation.

Nickel helps metals and alloys withstand the severest conditions. Nickel-containing metals safely hold liquid oxygen at a sub-zero cold that shatters many materials. America's first nuclear-powered merchant ship uses alloys with nickel in them to contain the tremendous pressures and corrosive conditions in its power

plant. And an alloy with nickel in it will enable the famous X-15 rocket ship to make the hot ride home from space without burning up.

Does your company have problems of these kinds in a product or a process? Why not write to us about them. Perhaps nickel or one of its alloys can help you.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO NICKEL

NICKEL MAKES STEEL PERFORM BETTER LONGER

HEAT FLOW **GASKETED JOINTS**

Transmission of heat through gasketed joints is undesirable in many applications. Here are suggestions for reducing it.

E. M. SMOLEY Research Physicist, Armstrong Research and Development Center

The problem of heat transmission in gasketed joints has recently been intensified by the trend toward smaller, more compact designs.

A typical example is found in some small gasoline engines where the fuel tank is located above the combustion chamber, separated only by a resilient gasket. This is illustrated in the diagram at the right. Heat enters the bottom of the flange, and the problem is to minimize the flow of this heat to the top flange.

Armstrong research engineers recently studied the mechanics of the heat transfer problem in applications of this kind. As a starting point, they calculated the thermal conductivity ("k" factor) for each class of Armstrong gasket materials. The values are listed in the box below.

THERMAL CONDUCTIVITY VALUES FOR GASKETS

ARMSTRONG MATERIAL	Thermal conductivity kss Btu-in hr-ft ² -F°	
Cork compositions	0.34 to 0.49	
Accopac cellulose fiber materials	0.55 to 1.17	
Cork-and-rubber compositions	0.79 to 1.32	
Accopac asbestos fiber materials	1.16 to 1.58	
Synthetic rubber	3.22	

As the table shows, all the tested gasket materials have relatively low "k" factors, ranging from 0.34 to 2.22, and thus are good insulators relative to the metal parts of a flange assembly. The "k" factor of aluminum and its alloys, for example, ranges from 612 to 1548; of carbon steel,

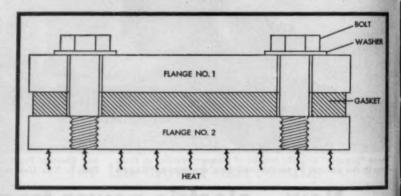
from 313 to 360; and of stainless steel, from 104 to 165. With the "k" factors of each element known, it is possible to calculate the amount of heat transferred by conduction, using the basic heat flow equation:

$$Q = \frac{k A (t_2 - t_1)}{d}$$

 $Q = \frac{k A (t_2 - t_1)}{d}$ In this, "Q" is a measure of heat flow per unit time; "k" is the thermal conductivity; "A" is the area of the gasket. The difference t2 minus t1 is the temperature difference across the

To further reduce transfer through the bolts, it is suggested that flat washers be die-cut from heat-resistant Armstrong materials (Accopac AN-890 or N-852) and placed between the metal washer and the flange. These should help to insulate the bolts.

Although no one recommendation can be made that will solve every heat transfer problem, the Armstrong studies indicate several general directions in which to proceed: (1) give preference to gaskets having the low-



thickness of the gasket; "d" is the compressed thickness of the gasket.

The total heat flow is the sum of that which passes through the gasket and the bolts, and separate calculations must be made for each.

Normally, of course, most of the conducted heat moves through the bolts, since they are the only metalto-metal contact. If aluminum bolts are used, heat flow could be reduced by roughly one-third by substituting carbon steel. Stainless steel bolts would reduce it still more.

est thermal conductivity; (2) use the thickest gasket possible; (3) examine the possibility of changing to metals having a lower "k" factor in flangebolt construction; (4) keep the gasket area as small as possible; (5) try insulating the bolt by using a washer cut from Accopac AN-890 or N-852.

If you have a specific problem related to heat transfer, we will be glad to make suggestions if you will submit details to us. Write to Armstrong Cork Company, Industrial Division, 7110 Dean Street, Lancaster, Pennsylvania.

Armstrong GASKET MATERIALS

raymond spilman: "from the middle ages to today ... a designer's greatest asset is his perceptivity"

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"Today's industrial designer is a problem solver. He must help create a new product, extend its economic life to the Nth degree, yet be able to pronounce the obituary before it stagnates in the market place." Address before the Peabody College Arts Museum, February 21, 1961









spilman talks design

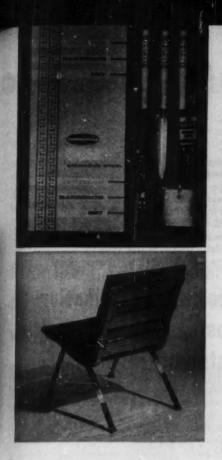
Raymond Spilman likes to contrast today's industrial designers with the artist-craftsmen of early civilization. In the Middle Ages the artist-craftsman's products and wares reflected his interpretation of the society of his time as testified by the remnants of pots, vases, tools and weapons, pictures and decorations turned up by probing historians. It was a relationship that continued until about 1750, and it ended when the invention of mass production in England separated the artist from his craft. A new relationship was born in 1929.

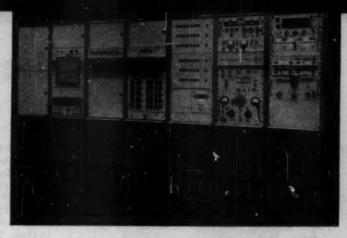
What caused it? Spilman says that the industrial designer was the first to recognize that the machine of mass production was not a monster but a new tool that, properly understood by the designer, made it possible for him to establish a direct emotional and visual understanding between the consumer and himself. Spilman feels that now, more than ever, it is up to the designer to retain that close relationship—better it if he can—because so much of our economy depends on it.

Pursuing that relationship a bit further, Spilman feels that design must transmit a sense of discipline, form and completeness between designer and consumer. He says that "today's industrial design function is a living, breathing, working part of our daily economy, with its own professional standards, requirements, good and bad uses." Esthetics included, he believes that "the designer is critically concerned with the market cycle of product acceptability."

Industrial design was born, according to Spilman, when the designer recognized that it would profit not only himself but the product user to create a product that was as functional as it was attractive. Advancement and progress are important to the consumer. Monetary profit is important to the manufacturer. Provide the first two and the last will take care of itself. Spilman illustrates his theory of design by citing the example of an early electric refrigerator. It worked, and it took the place of clumsy, troublesome iceboxes. The designer had created a product that profited both consumer and manufacturer.

What kind of a man is an industrial designer? According to Spilman, he is a man with an art education who has distinct mechanical sense. He is an intellectually curious person, creative in one or more unique ways,







keenly aware of the mass mind and its probable reactions. He understands that industrial design is a comprehensive lateral form of visual creativity that can be applied to a multitude of diverse problems. His work cannot be pure guesswork, nor can it be pure art.

What is the weakest link in a good design program? Spilman does not think it is the designer or the consumer. He is quite outspoken in his views on the lack of management understanding of the detailed work and time required to successfully design a new product. Management, he feels, is prone to forget the fact that new designs are getting more and more difficult to obtain because more companies are using visual design effectively. "More than ever, the only bargain price in visual design is an adequately budgeted design program," he says.

Spilman also has strong feelings about the materials he designs with. He feels that steel, for instance, represents lightness and strength. The designer must select material by appearance, manufacturability and cost. If the consumer believes that same material denotes strength and stability, and that it gives him a feeling of strength, physical security and a mental/psychological feeling of safety, so much the better. It's no coincidence, then, that many of Spilman's most successful designs are of steel. In a computer housing he designed, the entire case, except for the grille at the bottom, bar handles and name plate, is made of steel because it was the best material for strength, cost and ease of finish. For another client, Spilman designed a steel flour sifter. He used steel for cleanness, brightness, strength and lightness. For a light look, strength and durability, the frame and back plates of a chair were designed of steel. Dormitory furniture was designed of steel for strength, appearance and ease of finishing. Spilman feels that Stainless Steel is the ultimate design material. A barbecue turner he designed of Stainless is strong, lightweight and easy to clean. Its Stainless surface will resist corrosion and stay bright, clean and sanitary.

Steel is the modern metal. Little wonder that designers like Raymond Spilman consider steel the most versatile material in industrial design.



News about the USS steels to



USS Vinyl Coated Steel Sheet challenges the designer's imagination

Here is a steel that has unlimited uses for the designer of consumer or industrial products—USS Vinyl Coated Steel Sheet. Tough Vinyl, in any color or texture, is bonded to strong steel sheet. It is a design material that is inexpensive, tough enough to take hard knocks, strong enough to be used in the most demanding applications. USS Vinyl Coated Steel Sheet is easy to clean, resists spotting and staining, and can be fabricated easily and inexpensively. It can be shaped and the surface won't crack or peel.

Die lubricants, alkaline cleaners, fountain pen ink, alcoholic beverages, detergents, acid cleaners, nail polish or fruit acids won't spot it. It can be slit, punched, drawn or roll formed, lock seamed or welded without damage or discoloration to the finish. It is competitive in price with other materials. USS Vinyl Coated Steel Sheet will not support combustion, and has a dielectric strength of 750 volts per mil of coating thickness. It is available in gages from 16 through 32, widths from 24 to 52 inches, in coils up to 10,000 lbs. Vinyl coatings are 0.008 inches to 0.020 inches thick. There are a number of standard textures, but custom textures are also available from the mill.

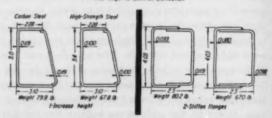
Some suggested uses for USS Vinyl Coated Sheets: room dividers with different-colored face panels that are interc' angeable; a scuffproof space heater in any color or texture; an easily cleaned, scuffproof lobby door; vari-colored steel shelving; office chairs that are attractive and strong; school desks that will take many semesters of hard knocks, yet keep a first-term look; a tape dispenser that has extra sales appeal. Other suggested uses: building interiors, doors, appliances, furniture, automobile and station wagon interiors, railroad car interiors, business machines, switch panels almost any product that is subjected to abuse. Write United States Steel for additional information on USS Vinyl Covered Steel Sheet.

How to control deflection, cut costs, save weight with high strength steel

If you design fabricated structures, you can save basic material costs, save money and reduce weight by using a steel with a higher yield strength. In box beams, for instance, strength in bending is proportional to the yield point. If you use a steel with a higher yield point, you can decrease thickness and use less steel. When the elastic modulus is given, deflection is in direct proportion to the yield point.

High-strength low-alloy steel members with a 50,000 psi yield point may be designed ½ lighter than those of 33,000 yield point carbon steel, but deflection is 1½ times as great. When using alloy steels in the 100,000 psi yield strength range, weight can be reduced by ¾ while deflection increases to approximately 3 times that of a carbon steel beam.

Two Ways To Control Deflection



There are times when deflection limits require that high strength members bend no more than carbon steel members. There are two ways to keep deflection equal and still use high strength steel. The left drawing shows a structural member deepened so that moment of inertia can remain the same though the material is thinner. In the drawing at right, the material is redistributed into overlapped areas at top and bottom. This stiffens the structure without adding



This mark tells you a product is made of modern, dependable Steel.

match designs

height. Note that the thickness of the inner flange is reduced more than thickness of the outer flange.

Summary: It is well for the designer and fabricator to be aware of potential savings in weight and costs, plus improved product performance, by using high strength steels.

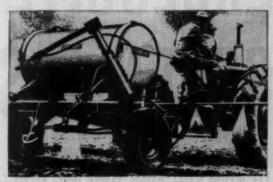
Free book, calculator and new movie tell you how to weld @s\$ "T-1" Steel



If you are thinking about USS "T-1" Steel in your shop, you will be interested in U. S. Steel's free book, "How to Weld USS "T-1" Steel," a heat input calculator and a new 18-minute 16mm color motion picture. The book is written in simple language and describes the "Do's" and "Don'ts" in welding "T-1" Steel. The circular computer helps you choose the proper welding machine settings. Both will help every welder to do a more reliable job and make his work easier.

The book is based on the experience of U. S. Steel's many field service men whose jobs are to help customers fabricate "T-1" Steel. It contains the results of nine years of work with hundreds of users, and shows how to apply common practices in the welding of "T-1" Steel. Welding "T-1" Steel is not particularly difficult, but it is different from welding most other high strength structural steels, and requires a basic knowledge of the metal, the electrodes and proper welding procedures.

The movie is also titled, "How to Weld USS "T-1" Steel" and can be used with the booklet and calculator to train welders. Movie, booklet and calculator are available free (the movie on a loan basis) from U. S. Steel. Write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.



Stainless Steel farm chemical tanks outlast others 10-to-1

More and more farmers are turning to liquid farm chemical (herbicides, pesticides) and fertilizer application. It is cheaper, faster and easier than former methods. It also presents problems. The biggest is corrosion. Corrosive farm chemicals soon weaken ordinary tanks. Corrosion clogs pipes, nozzles and booms, which means irksome delays and expensive replacement costs. The solution for this big problem: Stainless Steel tanks.

Stainless tanks cost more initially but they are worth more because they outlast ordinary tanks 10-to-1. Stainless Steel's tough, smooth finish resists the corrosive attack of all farm chemicals. Stainless is easy to clean, so farmers can switch chemicals after a quick water rinse between jobs. If a farmer has a Stainless tank he saves in these ways—one piece of equipment serves many purposes; his equipment will last up to ten times longer; and he has fewer problems with down time because of clogged equipment.

Stainless Steel is the designer's metal. It is strong, has superior corrosion resistance, excellent formability and heat-resisting properties. It is attractive and gives any product a competitive edge in the market place. If Stainless Steel can solve a problem for you, or make your product better, write United States Steel for further information. USS and "T-1" are registered trademarks.



United States Steel



EXCLUSIVE! GOODYEAR GREEN SEAL V-BELTS

to give you sets that are precision-matched in length to outperform...and outlast...all others

At no extra cost, GREEN SEAL V-Belts also give you:

Dimensional stability throughout the life of the belts via highly shrink- and stretch-resistant 3-T Process Cord or airplane-type steel cable.

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The most complete line of V-Belts in the industry—easily and quickly available through our nationwide network of distributors. Still another "plus": The G.T.M.—Goodyear Technical Man—is available to help you select the right belts for any drive.

For your best buy in multiple drive belts—including new money- and space-saving HY-T Wedge V-Belts—look to Goodyear. Also, get the full story on P.D. (positive drive) Belts and Variable Speed Belts from your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Akron 16, Ohio.



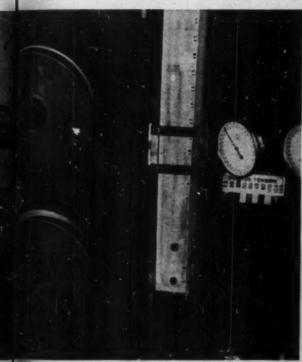
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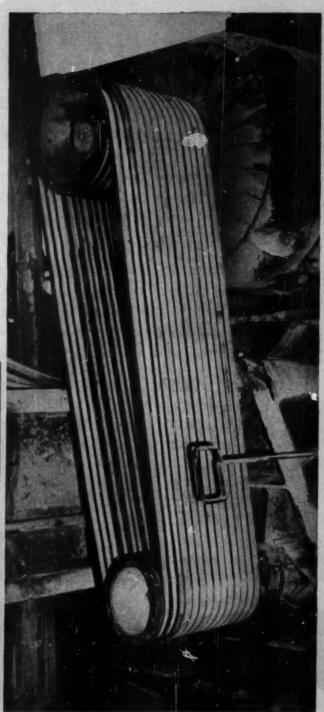
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INDUSTRIAL PRODUCTS

CODES TO 1/32"...



Length-coding GREEN SEAL V-Belts to 1/32" not just 1/10" like most belts—takes this ultraprecision machine. Only Goodyear has this type of equipment, which is set by means of finetolerance steel templates to insure accuracy.



Harnessing this big, 22-saw stonecutter for 3 full years required COMPASS-V-Steel Belts by Goodyear. Over this period, the Goodyear belts helped carve up 20 tons of rock a day-over 15,000 tons in all. Normal V-belt life in this type of rugged service is a scant 6 months.

General Electric Makes Eddy-current-coupling Drives

And they're dependable drives. The complete line includes water-cooled and air-cooled eddy-current couplings. We call them **KINATROL** drives. Ratings are from 1 to 150 horsepower, operating from standard a-c power.

A General Electric KINATROL drive is not just another eddy-current coupling. For instance, in the water-cooled coupling, water control is packaged. You'll see much less external piping. Furthermore, the coupling is protected from flooding—and the air gaps are dry, preventing corrosion.

couplings are compact, field proven and dependable. General Electric has had a good deal of experience in the engineering, manufacturing, and application of packaged adjustable-speed drives. And we know how important service is to a customer.

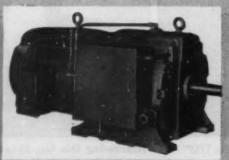
with the kind of service you can depend on. Please call your nearest General Electric Sales Office for further details.

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821-07A



COOLED, 7-1/2 to 160 HP



WATER COOLED, 25 to 180 HP



AIR COOLED, 1 to 5 HP

DIRECT CURRENT MOTOR AND GENERATOR DEPARTMENT

GENERAL E ELECTRIC

ERIE. PENNSYLVANIA Circle 233 on Page 19

instead of just carbon steel tubing, say TIMKEN CARBON STEEL

TUBING

People who visit the Timken Company's steel plants are sometimes surprised to see carbon steel tubing being made by the same careful practice used for alloy steels. Extra care in melting, careful conditioning of billets, all the special

inspection methods that safeguard Timken® fine alloy steel also apply to our carbon steel tubing.

That's why Timken carbon steel tubing is better. And you pay nothing extra for it. In fact, you pay less because our precautions pay off in better uniformity and concentricity. You may be able to buy a lighter tube that will finish to your required dimensions.

Next time you need carbon steel tubing, call the experts. Let the Timken Company's Tube Engineering Service calculate the tube size which will give you the best value for your dollar.

The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Also manufacturers of Tapered Roller

Bearings and Removable Rock Bits.

TIMKEN FINE STEEL

TIMKEN ALLOY STEEL AND SEAMLESS STEEL TUBING ARE AVAILABLE FROM STEEL SERVICE CENTERS IN MORE THAN 40 CITIES IN THE UNITED STATES

Call on us at the National Metal Exposition, Cobo Hall, Detroit, October 23-27, Booth 739

Access Fasteners:

How Quick is Quick?

By J. K. Barry Chief Product Engineer Southco Div., South Chester Corporation

A dangerous temptation to overspecify often creeps into the process of calling out a quick-access fastener. It becomes possible even for the most experienced product designer to place so much emphasis on speed of operation that other aspects of good design practice may suffer.

Except in rare cases it is doubtful that a difference of 2 to 4 seconds in the time required to actuate a fastener will be a vital matter to the operator. This is especially true when only one or two fasteners are used on a door or panel. The access time element, however, becomes more significant when a greater number of fasteners must be operated to open a single door.

Of equal importance in the selection of a fastener are such considerations as simplicity of design, strength of construction, smoothness of operation, and ability to overcome panel deformation and variation in material thickness.

A quick release fastener that will perform smoothly under conditions of precise alignment and uniform material thickness might be difficult or slow to operate where thicknesses vary and doors become misaligned. But a fastener designed to open with several turns (or a quarter-turn pawl fastener with a selfadjusting feature) might offer quicker access and less trouble by compensating for variations in material and alignment.

Ject a fastener suited to the conditions of your application. Look for one that can be purchased from stock and installed easily with standard production equipment.

Consider fastening in the early stages of design. You'll avoid the unpleasant choice between redesigning your package at the last minute, or inventing an expensive fastener to fit it. Shown below are some basic forms of the turn-operated quick-access fastener as made and stocked by Southco. Many major variations in design as well as differences in size, head style, etc. will be found in the new Southco Fastener Handbook. Send for your free copy today. Write Southco Div., South Chester Corporation, 237 Industrial Highway, Lester, Pa.



Lion Quarter Turn Fastener

For split-second actuation. Meets Mil Spec MIL-F-5591A (ASG). Excellent under conditions of vibration or where a number of fasteners must be used on the same door.



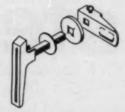
Southco Screw Fastener

Opens with two or three turns. Rugged, quickly installed. Overcomes misalignment of door and frame, tolerates variation in material thickness and deformation of panels.



Retractable Screw Fastener

Easily installed by flaring stand-off into door. Captive screw assembly engages tapped hole in frame, needs no receptacle. Ample float tolerates misalignment.



Universal Cabinet Latch

Quickly attached to door with special push-on clip. Fits any door or frame thickness; operates with a quarter turn. Excellent for large doors of gauge metal.



Adjustable Fastener

Pre-assembled and quarter turn operated; latches against frame (even against a rough casting surface). An extra turn of the knob tightens door to compress gasketing, resist vibration. Fits variety of door and frame thicknesses.



Panel Latch

A spring-loaded, quarter turn latch assembled with one set screw. Uses minimum inside space. Arrow indicates pawl position, permits visual inspection.

SOUTHCO FASTENERS

OHMITE RESISTORS

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THE EXACT RESISTOR YOU NEED-WHEN YOU NEED IT-FOR EVERY INDUSTRIAL AND MILITARY REQUIREMENT

Fixed ... adjustable ... tapped ... noninductive ... precision metal film and encapsulated wire-wound . . . thin type . . . high-current-practically any resistor you need, you can find in the Ohmite line.

W ORLD'S LARGEST STOCK FOR IMMEDIATE DELIVERY—Chances are Ohmite's huge stock of several million resistors in more than 2000 sizes and types contains a unit that fits your requirements. Many types are also available through Electronic Parts Distributors located across the Nation.

OUR CUSTOMERS KNOW THE VALUE OF OHMITE QUALITY-Y When a purchaser sees Ohmite resistors in a piece of equipment, he knows that equipment is designed and built for dependability.

O HMITE ENGINEERING ASSISTANCE ASSURES THE RIGHT UNIT— Selecting the right resistor for the job is sometimes a tough problem. Why not call on Ohmite application engineers to help out. Take advantage of their specialized skills and background.

> Write on Company Letterhead for Catalog and Engineering Manual 58



OHMITE Quality Components

OHMITE MANUFACTURING COMPANY 3618 Howard Street, Skokie, Illinois

RELAYS . R.F. CHOKES . TANTALUM CAPACITORS VARIABLE TRANSFORMERS . GERMANIUM DIODES

For Long Life and Power Economy



The new CLARE Type LF, magnetic latching subminiature relay offers designers simplified circuitry in small space by providing latching effect without transistors. Magnetic latching results in power economy.

The Type LF is available with either 2-coil or 1-coil configuration. The 2-coil relay allows complete control of the latching operation within the relay and provides an extremely compact operating unit. The 1-coil relay is somewhat more sensitive; it is adaptable to existing circuits where outside control is provided. (See opposite page for specifications and circuit diagrams.) The Type LF provides the same wide range of mounting arrangements and terminals as the CLARE Type F relay.

FOR NON-LATCHING



Type F Subminiature Crystal Can Relay

then received your sensities. It is built to withstand to a persture extremely, heavy shock and extreme vitivally Contacts, rated at 3 amperes, are excellent for time to circuit operations. Send for Design Manual 283.



operations
1.0 amps/c, 116 VAC resistive—100,000 operations

Dry Circuit:

1,000,000 miss free operations when subject to
conventional dry circuit requirements.

Temperature—+1751 C to —65° C

Shock-1000's for 1/2 sine wave 11 ± 1 MS pulse

Linear Acceleration—100g's minimum Vibration—250" DA or 30 g's, 5-2000 cps.

Humidity & Salt Spray-MIL-R-5757D

Numidity & Salt Spray-Mil.-R-5757D
Encloaures: Tinned brass cover with fungus-recision
finish. Hermeticulty scaled and filled with dry
nitrogen at atmospheric pressure.

Centact Arrangement—2PDT latching
Terminals—Plug-in (3/16" straight), solder hook, 3" straight
Wising—Two coils (as shown on drawing above)
One coil (as shown on drawing above)
Weights—54 oz, for plug-in
"22 oz. for 2 stude, 3" leads

operate and hold when t

For coil and mounting data on CLARE Type LF relay send for CPC-12. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. Cabie Address: CLARELAY...

C. P. CLARE & CO. Relays and related control components











461 (with adjust able draw hook — All the features of type 461, plus draw hook adjustable



51L — Ultimate tensile strength up to 500 lbs. Hook adjusts by simple rotation

There's a Camloc Fasten/eered Universal Latch to do the job... and do it better!

You may never have to crate an anteater or ship a zebra. It's just one way of demonstrating the wide range of tensile strength requirements met by Camloc Universal Latches. For any job... from A to Z... 500 pounds or 4500 pounds ... shipping containers or component assemblies of any size ... Camloc can provide the latch to fill your specifications.

At Camloc the science of modern fastening is called FASTEN/ATION. And, FASTEN/EERED Camloc latches provide the ultimate in protection, ease of installation, and simplicity of operation. For example: draw hooks always stow flat when latches are open. Latches can't open under shock or vibration. Clean, crisp appearance enhances any product or component.

Have a special fastening or closure problem (even a reusable zebra case)? Camloc can provide a FASTEN/ATING solution. Write today

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Dow Corning

SILICONE NEWS

for design and development engineers . No. 87

Now: Instant Molds

Think of a silicone rubber you can pour into place to produce flexible molds, to encapsulate electronic assemblies, to make a one-of-a-kind gasket or seal. Think of such a material and you think of Silastic® RTV.

Because it is fluid rubber, Silastic RTV readily flows in and around complex shapes. Once in place, Silastic RTV sets up without heat in a few hours to a solid silicone rubber accurately reproducing the finest detail. It strips readily from the original and you have a flexible mold now ready to receive almost any molding material, even molten metals up to 500 F.

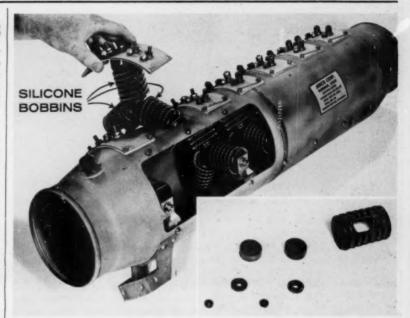
Shallcross Manufacturing Company, Selma, N. C. found it feasible to shortcut production by utilizing Silastic RTV molds when encapsulating electronic components with epoxies. Here's the simple procedure Shallcross followed:

Step. 1. Make the mold. Silastic RTV is poured over the mold forms . . . flows smoothly around the form. Result: a void-free flexible mold that withstands temperatures to 500 F . . . doesn't shrink or distort on aging.



Step 2. Components to be encapsulated are placed in the mold and the material is poured over them. After the encapsulant sets up, parts are ready for removal.





AIR-CONDITIONED HEAT

How to keep a comfortable temperature level in passenger cabins while planes are on the ground? Janco Corporation, Burbank, California, solved this problem for Convair 990's and other aircraft having pressurized cabins by designing auxiliary electrical heaters to be installed directly in the air ducts of the plane's air conditioning systems.

Rated at 15 KW input, 115/200 volts, 400 cps, 3-phase, the space-saving Janco heaters are capable of heating 90 pounds

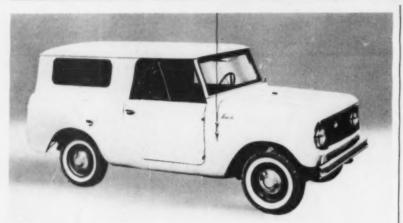
Step 3. Parts release quickly and cleanly from the flexible Silastic RTV multiple cavity form. The form is clean — ready for next use. (Cont. Pg. 2)



of air per minute at sea level (29.92 inches of mercury) to effect a temperature rise in excess of 45°F. An important key to the efficiency and reliability of these heaters is the inherent toughness of parts made of Dow Corning silicone molding compound.

These parts include 21 coil bobbins on which resistance wire is wrapped to form radiant heater elements and an assortment of 98 washers that secure the bobbins to metal mounts. In actual service, the silicone molding compound parts are exposed to oven-like temperatures that would "wilt" most plastics and are unaffected by rapid temperature cycling that would crack many conventional materials

According to Janco's materials control engineers, the silicone molding compound was specified because (1) this material has superior physical and electrical properties at -67 to 500°F, (2) is easy to mold into complex shapes designed for strength and light weight, and (3) the silicone parts are completely odorless and give off no offensive vapors despite high operating temperatures. Janco molds the parts into finished shapes in a transfer molding machine, post cures them up through 500°F. (Comt. Pg. 2)



A current confirmation of the old adage that "a quality product will always sell" is the Scout all-purpose vehicle manufactured by International Harvester Company. Though the company originally planned to produce only 18,000 units the first year, it topped that mark in July, may turn out as many as 40,000 the first year.

Why is the Scout scoring such a smashing sales success? One answer is its versatility. But another just as important success stimulant is the dependable performance designed into this vehicle by IH engineers. Take the front and rear crankshaft oil seals, for example. In the Scout, they're made of Silastic®, the heat resistant silicone rubber developed by Dow Corning.

Why Silastic? Because Silastic stays rubbery - maintains a positive tight seal capable of taking a beating even when the "heat's on". And it's really "on" when oil temperatures can reach 270-280 F as they may do in the Scout's 4-cylinder Comanche engine. A truly imaginative piece of design engineering, the Comanche is basically the right bank from the 304 cu. in. displacement engine of International Harvester's small V-8 series. Since Silastic oil seals, made by Yale Rubber Co., Sandusky, Michigan, passed all high temperature performance tests and are standard equipment in the small series V-8's, why change?

By the way, these small series V-8 engines power International Harvester trucks at GVW up to 41,000 pounds.

Just as Silastic met the material requirements of this design, it can meet your needs for rubber parts to operate at extreme high and low temperatures. For full information, circle No. 243

MOLDING COMPOUNDS (Cont.)

Dow Corning recently established a special facility to render engineering service to fabricators and end users of silicone molding compounds. The staff at this facility will gladly assist you in getting the most value from thermosetting silicone compounds. For information about this service and silicone compounds, circle . . No. 241

INSTANT MOLDS (Cont.)

The moldmaking material Shallcross previously employed required a 300 F cure, distorted on aging and cost substantially more. In contrast, Shallcross engineers found Silastic RTV molds are easier to handle . . . have a 400% longer service life . . . don't distort, shrink or alter their shape during storage . . . give finer detail. For information on what Silastic RTV can do for you, circle No. 242

Announce materials engineering conference

Further evidence of the growing recognition for the importance of materials engineering is found in the announce. ment that the American Institute of Chemical Engineers will sponsor a daylong materials engineering program during its 1961 annual meeting. Scheduled for December 7 in the Commodore Hotel, New York City, the conference will be open to all interested persons, AIChE members and nonmembers alike.

Chairman for the AIChE Materials Engineering program is E. G. Bobalek, Professor of Chemical Engineering at Case Institute of Technology. Dr. Bobalek has announced the morning session will feature a panel discussion with the theme "Materials Engineering, the Modern Concept and Present Day Practice". Members of the panel are H. R. Clauser, Editor, MATERIALS in Design Engineering; S. W. Herwald, Vice President. Westinghouse Electric Corporation; G. A. Hochwalt, Vice President, Monsanto Chemical Company; and L. H. Van Vlack, Professor of Materials Engineering, University of Michigan. The afternoon session of the program will be devoted to the presentation of papers by leading aerospace authorities and others in the materials field.

If you're interested in materials or materials engineering, and expect to be in the New York City area at the time of this pace-setting conference, why not plan to attend?

The event: AIChE Materials Engineering Conference

December 7, 1961 The date: The place: Commodore Hotel The time: 9-11 a.m., 2-5 p.m.

For complete information about the conference, including abstracts of all papers and names of all scheduled speakers, circle No. 244

Space Age Silicones are described in new brochure containing thirty typical application stories. Utilization of silicone compounds, fluids, lubricants, protective coatings, rubbers, resins, potting materials and sealants are illustrated for your consideration. This valuable brochure offers solutions to many problems encountered in designing space age aircraft and ground sup-No. 245 port equipment.

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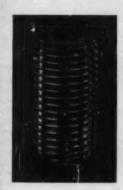
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NEW...AND TO THE POINT!



That, in a phrase, is the Unbrako set screw with patented* counterbore knurl—a fastener of unparalleled vibrational holding power.

A direct evolution of the already proven Unbrako knurled cup point screw, the new Unbrako High Torque permits your design ingenuity extraordinary freedom. No need now for the redundancy of two set screws because you're afraid one will work loose. No need to sacrifice the adjustability of a set screw for a permanent pin fastening.

As you see from the illustrations, with the counterbore knurled cup point, the angle at the point of entry is extremely acute. This permits easier and deeper penetration, greater knurl contact. The result is a positive locking action before ... and unparalleled vibrational holding power at the recommended seating torque.

In addition to the counterbore knuri, the new UNBRAKO High Torque offers another advance unique among set screws—the Hi-Life Thread. A smoothly radiused thread root not only distributes stresses to permit significantly higher tightening torques, but also adds metal to this critical area between the root of the thread and the extra-deep UNBRAKO socket.

Make sure your designs get the reliability they deserve. Specify UNBRAKO—"the one that won't work loose."

The new Unbrako High Torque Set Screw—with counterbore knurl and Hi-Life threads—comes in sizes #4 through 1 in. Your authorized Unbrako distributor has a complete supply on hand now. For a copy of our new booklet on Unbrako High Torque Set Screws, write to Standard Pressed Steel Co., Industrial Fastener Division, SPS, Jenkintown 18, Pennsylvania.

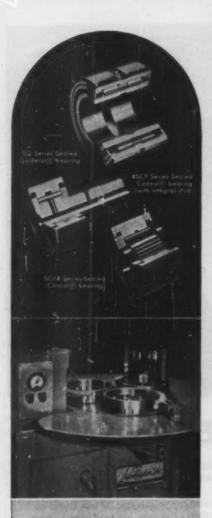
*No. 2,992,669-patented July 18, 1961



Smoothly radiused root of Hi-Life thread distributes stress concentration at critical point, thus making possible UNBRAKO's higher tightening torques.

where reliability replaces probability





Seals keep lubrication in, abrasives out in SCF CAMROL lapping machine use

Sealed SCF Series CAMROL bearings position conditioning rings into which work pieces are placed in Crane Packing Company LAPMASTER lapping machines. The bearings roll in a loose abrasive and oil environment. The user reports longer life with less maintenance than the ball bearings formerly used.

McGILL® prelubricated and sealed bearings

insure product performance

Contamination and loss of lubricant cut bearing life drastically. That's why more and more manufacturers are specifying McGill sealed bearings. Integral seals extend bearing life and keep equipment in service even under adverse field conditions.

You can expect full rated life from McGill sealed bearings in applications involving exposure to dirt and grit or contaminants which tend to dilute the lubricant. They're also ideal where re-lubrication is impractical or difficult.

McGill sealed GUIDEROL and sealed CAMROL bearings eliminate the need for expensive auxiliary seals. Each bearing is complete and they are easy and economical to apply.

Sealed CAMROL bearings are available in roller diameters up to 4", with or without integral stud. Also available with extra heavy stud. Sealed GUIDEROL bearings are available in shaft sizes from 5%".







"Live Center" application

Motor Tool Manufacturing Co, reports that the sealed GUIDEROL bearings used in their new heavy duty live centers will carry heavier radial loads for their diameters than any bearing they know of. They also state that performance difficulties run less than 1% in spite of severe operating conditions.

Sealed GUIDEROL and Sealed CAMROL bearings used by JOHN DEERE

McGill Sealed GUIDEROL bearings at each end of the connecting rods and at the end of the swing-arm sickle drive of John Deere No. 10 side-mounted mowers reduce friction and assure efficient field operation. The sealed GUIDEROL bearings in their exposed positions are indicated in the photo above at left. The swing-arm sickle drive bearing outlasts three bronze bushings in the application. Oscillating loads of approximately 700 pounds are encountered in this position. The connecting rod bearings are subjected to reciprocating loads of 1600 pounds.

Deere also uses sealed SCYR series CAMROL bearings in plunger head guider rollers in their 323-W balers.



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MULTIROL-GUIDEROL-CAMROL-CAGEROL

McGILL MANUFACTURING CO., INC., Bearing Division 200 N. Lafayette Street, Valparaiso, Indiana



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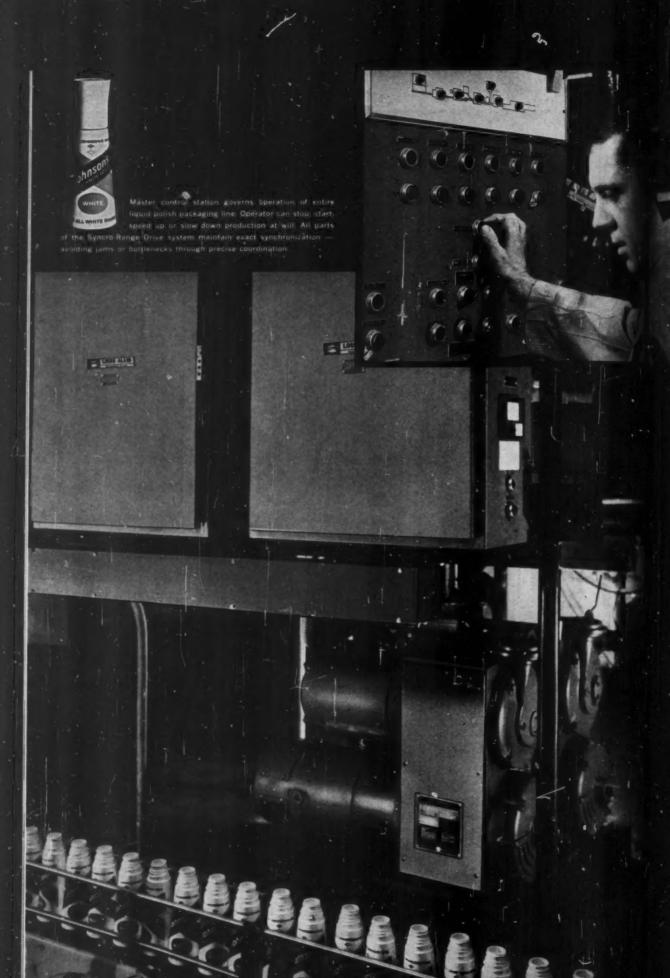
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The key components of the Syncro-Range Drive...



Adjustable Frequency Power Supply . . .



... and Standard or Syncro-Spede Motors!

LOUIS ALLIS SYNCRO-RANGE DRIVES automate liquid polish lines

Johnson's Wax, renowned wax and polish producer, uses Syncro-Range Drives for exact control of process lines

Controlling speed of the precise, mass-production lines for their new, highly successful liquid shoe polish was the task Louis Allis engineers had to solve for Johnson's Wax.

The problem was to time the flow of plastic bottles, liquid polish, wool daubers, and caps into the packaging lines at precisely equal rates. Flow rate must be adjustable so the lines can be slowed down or speeded up. And the entire packaging operation must be controllable from a single master control. The Louis Allis Syncro-Range Drive solved the problem.

Syncro-Range Drives provide synchronized speed of any number of motors from a single control. It is a "packaged system" comprising an adjustable-frequency power supply operating on 3 phase, 60 cycle power input...a group of Syncro-Spede® synchronous motors which maintain exact synchronism regardless of varying load...and a control which permits the speed of the entire group of motors to be simply adjusted without losing synchronization. On applications for which exact synchronism is not required, standard squirrel-cage motors can be supplied.

You can readily see the advantages of the Syncro-Range Drive in systems or processes which require synchronized movement: multiple conveyors which feed consecutively; transfer lines; process lines; assembly lines requiring coordinated arrival of components; printing where one press feeds another; synthetic fibre spinning, drawing, or twisting; metal runout tables; and many other similar continuous-process machines which require the application of power at a number of points on the machine.

The Syncro-Range Drive is available with a choice of drive sizes to efficiently control from 2 to 200 (or more!) standard or Syncro-Spede motors of the same or different horsepower ratings. The Syncro-Spede motor is an A-C synchronous induction motor without slip rings or D-C excitation. It requires no more upkeep than a standard, squirrel-cage motor and can be supplied in open drip-proof, enclosed, or explosion-proof enclosures with mechanical modifications to match your requirements.

A sophisticated selection of control features are available in the system, including motor starters, main line circuit breaker or fusible disconnect switch, speed adjustment, speed indicator, remote control, and automatic control governed by temperature, pressure, or flow sensing devices. Controls can provide speed regulation accurate to 0.1% with 0% relative speed difference between motors!

Investigate the application of the Syncro-Range Drive system to your process. A trained Louis Allis motor application engineer is always available. You can reach him at your local Louis Allis District Office, or by writing direct to The Louis Allis Company, 459 East Stewart Street, Milwaukee 1, Wisconsin.



MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS



HANDY ALLOY DATA SHEET

HANDY & HARMAN ENGINEERING DEPARTMENT 82 FULTON STREET, NEW YORK 38, N.Y. TEC and

... How to choose between a soft solder and a brazing alloy

Handy & Harman provides two alloys that fit between "something stronger than the average soft solder but not as strong as a silver-brazing alloy." They are named TEC and TEC-Z and their flow points are intermediate between soft solders and silver-brazing alloys. Joints made by these alloys are strong in straight tension or shear. For instance, butt joints of cold-worked copper can be made having a tensile strength of about 25,000 psi. This is approximately 10,000 psi. more than can be obtained with tin-lead soft solders. TEC joints retain their strength at elevated temperatures much better than the tin-lead soft solders. As shown in the table below, the strength of the solder itself at 425° F is about the same

as a 50% tin -50% lead solder at room temperature in short-time tensile tests.

Applications — One example is a thermostatic bellows where the operating temperature is too high for soft solders (tin-lead), yet requires a joining medium which will not anneal the bellows. Another use is gun parts which require joint strength at higher than soft-solder operating temperatures plus corrosion resistance to solutions used in cleaning and blackening. Also for lamp bulb bases operating at approximately 350°-500° K Automotive applications and heat exchangers. TEC conforms to Government Specifications Mil-S-19234 (Nord); both TEC and TEC-Z are available in sheet, wire, powder, and preforms to specifications.

	TEC	TEC-Z
Silver	5% plus or minus 0.5%	5% plus or minus 0.5%
	95% plus or minus 0.5%	16.6% plus or minus 0.5% 78.4% plus or minus 0.5%
DH.	YSICAL PROPERTIES	
	TEC White	TEC-Z White
Welting Point Flow Point	640° F 740° F	480° F 600° F
Denalty (Troy oz/cu in.) Elictrical Conductivity (Cu = 100)	4.60 22.0%	4.53
Electrical Russetivity (Microhm-cm)	7.9	
STRENGTH	COMPARISON TEC vs. Pb-	SN
	TEMBILE STRENGTH LOS/SQ IIL	TENSILE STRENGTH LBS/80 IN.
	TEG	PD-SN
ROOM	16,400	2,500
200° F	4,400	650
425° F 500° F	2,600	Melts

The information and data on this page are available in our Handy Alloy Data Sheet. Ask for "TEC." Handy & Harman, 850 Third Ave., New York 22, N. Y.

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BARDEN PRECISION BALL BEARINGS

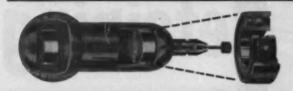
If your product needs bearings with close mounting tolerances, high geometrical accuracy, low torque or low vibration...if it operates at high speeds or high temperatures...specify Barden Precision.

For less difficult applications, the consistent quality, predictable performance and reliability of Barden Precision ball bearings can cut your assembly time, rejection rates and teardown costs.





For gear trains: Barden standard low torque bearings with closely controlled radial play and low eccentricity assure minimum backlash. Precision flanges provide accurate positioning surfaces and permit through-boring, eliminating the need for housing shoulders and reducing manufacturing and assembly costs. Sizes from .1562" to .8750" O.D.



For power tools, <u>aircraft and missile accessories</u>, and other high speed applications: Barden "T" retainer bearings with high load capacity and long, trouble-free life. Double shielded, grease lubricated "T" retainer bearings have operated more than 6,000 hours at 80,000 RPM. Sizes from .5000" to 3.3465" O.D.





For synchros: Volume produced precision bearings with extra-large outer rings designed to serve as end caps, thereby reducing synchron complexity and cost and increasing air gap accuracy. Barden-developed synchro bearings have closely controlled radial play and minimum eccentricity to meet tight air gap specifications. Sizes from .3750° to 2.0000° O.D.



For gyro gimbals and other torque-sensitive devices: Sarden "W" retainer reduces torque peaks and eliminates retainer lock. "W" retainer bearings save one gyro manufacturer \$100 per unit by reducing costly teardown. Sizes from 1.562" to .6250" O.D. Also other standard and special design gimbal bearings, including the Barden Dynamic Bearing with near-zero torque.

For gyre rotors: Barden special design end-bell bearings to increase accuracy and reduce assembly cost of miniature gyros. Bearings become part of spin mass and serve as end caps for wheel assembly, reducing mating part errors and improving squareness, concentricity and overall accuracy. Sizes from .615" to 1.016" O.D. Also other standard and special types including inertial gyro bearings with 20-microinch tolerances.





For memory drams, high precision spindles and other low runout applications: Barden duplex pairs with extremely low eccentricity and non-repetitive runout. Matched pairs with accurately controlled preload provide high load capacity, smoothness and long life along with radial and axial rigidity. Sizes from .3125" to 3.3465" O.D., deep grouve or angular contact.





Major manufacturers of instruments, mechanical components, computers, spindles and aircraft accessories regularly specify *Barden Precision* ball bearings for high performance mechanisms.

To specify Barden Precision ball bearings—prototype, pilot run or large volume production—ask for a Barden sales engineer to give you on-the-spot assistance, or write for Catalog C-3.

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SQUARE D PRECISION SNAP SWITCH AVAILABLE WITH 2 POLES!

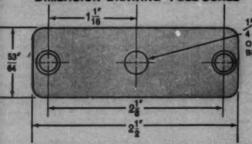
Same size and mounting as single-pole switch

Here's a precision snap switch which combines 2-pole versatility with high electrical ratingsand takes no more space than a single-pole

The new switch is available either singlethrow (2 normally open or 2 normally closed) or double-throw, and like the single-pole switch, it features: double-break contacts-large screwtype terminals-strong melamine case-zimplified mounting...a design which assures reliability, precise repeat accuracy and long mechan-



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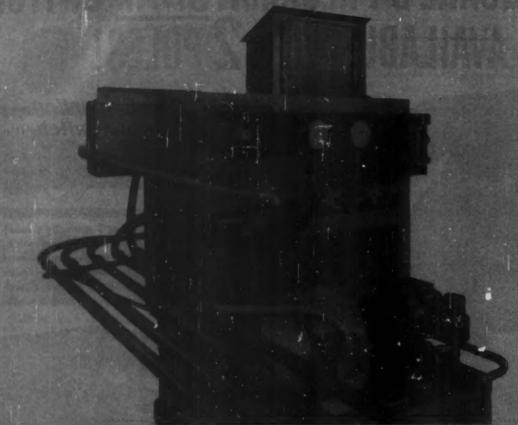
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Is hydraulic vibration one of your design problems?



Scans Associates solved this problem with a Racine Hydraulic System



"It would take an Act of Congress to make us use any equipment except Racine components for our porosity testing machines," says Mr. Vernon G. Converse, President of Scans Associates, Livonia, Michigan. The machine — which makes 4 different leakage tests on transmission cases in a 20-second cycle — must check porosity to ½ inch of water pressure. The machine hydraulically clamps the part firmly in place and tightly pluga all openings. Air pressure and vacuum are alternately applied inside the part, and changes in pressure are pneumatically measured. The slightest hydraulic vibration would distort the readings. "This demands hydraulic equipment that is both extremely sensitive and steady," states Mr. Converse. "Racine has always met both requirements perfectly." The Racine system in this application consists of a Model S variable volume pump, a self-contained 30-gallon reservoir, a 5HP motor and 3 Racine valves (one of them for pressure reduction).

If your application demands sensitivity and precision in hydraulic control, a compact Racine system can meet your requirements.

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Superior performance and unusually long service life, even in tough applications, is practically second nature to parts made of GRAPHITAR. That's because they combine GRAPHITAR's chemical stability, heat resistance, low coefficient of friction, adaptability to self-lubrication, mechanical

> strength, hardness and light weight. An everyday application of GRAPH-ITAR that illustrates well its versatility and remarkable performance can be found in the face-type valves employed in bulk station gasoline meters. These valves incorporate GRAPHITAR seats.

> Here, GRAPHITAR's corrosion resistance, chemical inertness and resistance to expansion or contraction under rapid temperature changes, allow the valves to provide a leak-tight seal with excellent wear characteristics.

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Self-aligning seals of GRAPHITAR are em-

ployed in rotary pressure

water, hot oil, trichlor-

variety of chemicals.

joints handling steam, ethylene, powdered talc and a



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Circle 254 on Page 19

how to pick

the one SOLID for the lob

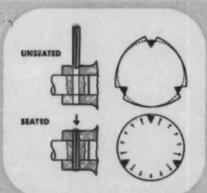
, (the solid Groov-Pin is still the safest, surest way to pin two parts together)

The Groov-Pin has the holding power of a press fit pin without the need for close tolerances, and the case of installation of a taper pin without the need for reaming.

You just drill the hole and drive the pin home. Once scated it stays there...no matter what the condition of shock or vibration.

Available in low carbon steel or other materials (stainless pins are Type 303, non-magnetic). Diameters from 1/32" to 1/2" are standard; specials are available and priced as standard in lots above 5000.

Write today for samples, comprehensive catalog, and acetate copy of this ad suitable for wall mounting. Groov-Pin Corporation, 1130 Hendricks Causeway, Ridgefield, N. J.



the unique GROOV-PIN locking principle

When a Groov-Pin is driven, the material dis-placed by the grooves is forced to flow back, setting up a powerful locking force. The abli-ity of Groov-Pin to hold under severe shock and vibration . . and its immunity to vibra-tion fatigue . . . has been thoroughly proved by the billions in use!

GROOV-PIN

fastening gears, pulleys, sprockets, collars and cams to shafts.





The basic Groov-Pin and most widely used. Has three full length grooves tapering from maximum diameter at one end to nominal diameter at the other.

locating pins, stop pins, hinge pins.





Grooves cover only one half of pin length. Used where holding power is not critical. Speeds assembly because ungrooved portion acts as a pilot.

clutch and brake pedals to cross shaft; bike pedal arms to brake shafts.





Recommended for severe shock and vibration applications, its full length parallel grooves give it great holding power. Type 3H is es-sentially the same, but has pilots on both ends suiting it for hopper feeds.

stop pins, locating pins,





Similar to Type Two, but taper on grooves is reversed, meaning groove end is inserted first. This is particularly good on blind hole applications.

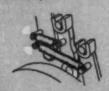
aircraft cowling, cover plates for buses, trucks.





Has three oval grooves half the length of the pin, centrally located. Especially suited for quick removal and replacement. Type Five is also well suited for hinge pin applications.

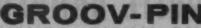
spring anchors, spring control pins.

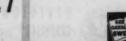






Same as Type Two, but with annular grooves on un-grooved end for spring anchor or retaining ring. Type Six is for through holes; Type Seven for blind holes. In addition, annular grooves may be machined to your specification — for use with retainer rings, for example. See catalog for standards.





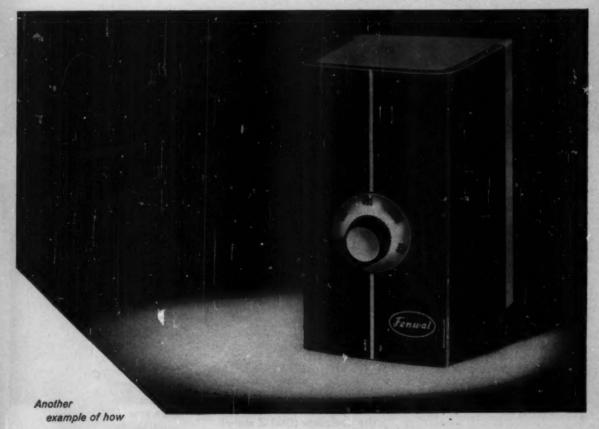
Here's Take-Your-Choice Versatility

with the Multi-option Fenwal 536 Temperature Controller It's so precise and yet so easily adaptable to an almost endless variety of temperature control applications, you become all but convinced that the transistorized Model 536 was engineered with only your needs in mind!

From its multi-option printed circuit board to its numerous interchangeable components, the Model 536 Temperature Controller spells versatility. On/OFF or proportioning control... dial for set point adjustment mounted externally or internally ... expanded scales for precise temperature adjustment — the 536 offers all these advantages! Five standard temperature ranges from —50 to +600°F ... separate potentiometer with graduated dial and knob for remote temperature adjustment ... capacity of 10 amp/110 VAC and 5 amp/230 VAC ... these choices are also available to you. And you pay only for the options you need!

The 536 is sensitive to within 0.1F°. And if you wish to build a multi-point control and indication system—either gradually or all at one given time—you simply combine the Fenwal-Model 580 Temperature Indicator with as many 536 Controllers as you require. Thermistor sensors enable fast response and ordinary copper lead wire may be used for connections. Removable interior of the Model 536 allows easy, safe installation and the instruments are smartly styled to perfectly complement modern industrial machines and interiors.

Find out more about how the precise Model 536 Temperature Controller can be adapted to your exact needs by writing to Fenwal Incorporated, 1910 Pleasant St., Ashland, Mass. Request Bulletin MC-195.





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to help you cut costs - improve product design and performance



the unique 360° full-circle ring offers design variations that open unlimited opportunities for new and improved designs. Available in a variety of materials and finishes from .375" to 48" diameter.

SINGLE TURN RINGS

—for economy—light weight Internal or external rings provide positive positioning or retaining for light thrust applications.



RESILIENT RINGS-attent

large tolerances—end play take-up Eliminate need for separate springs and washers—available in waved or dished designs.



DOUBLE TURN RINGS

medium heavy—extra heavy duty Available in varied thicknesses—3 standard series to choose from including the NAS 669/670 "deep groove" series.



BALANCED RINGS

—for critical balance operations
Minimize dynamic balancing problems on shafts with statically balanced rings — make ideal oil slingers.



MULTI-TURN RINGS

extra heavy duty—spacers

Can be coiled to any diameter, any number of turns for heavy loading or as spacers.



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—reinforce ring groove
Single turn, high tensile strength
rings greatly strengthen groove.



SELF-LOCKING RINGS

one piece—positive locking
Locking action keeps ring in groove
under high rotational speed, vibration, impact loading.



DEMOVAL NOTCHES

—variety of end conditions available
Rings can be supplied with removal
notches, slots, tabs, or hooks—
round, square, bevelled or tapered
addess.



Spirolox Rings have no lugs or projections—uniform wall allows installation with minimum clearance—no special tools are needed for installation or removal. Prototypes require no special tooling or set-up charges. Spirolox lends itself to deep groove design to withstand greatly increased thrust load. Covered by Government Specifications MIL-R-27426 for usage under Government contracts. Ramco engineers will be glad to work with you on the solution of difficult problems.

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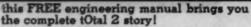
the improved die-formed retaining ring.

Circolax as well as Spirolax provides the answer to easy.

Lichtweight, low cost assemblies and reduced manufacturing costs. Made in a variety of types and sizes for the smaller costs and logical provides the control of the control

- . * "Deub pri bye" design pernuts maximum thrust with minimum weight.
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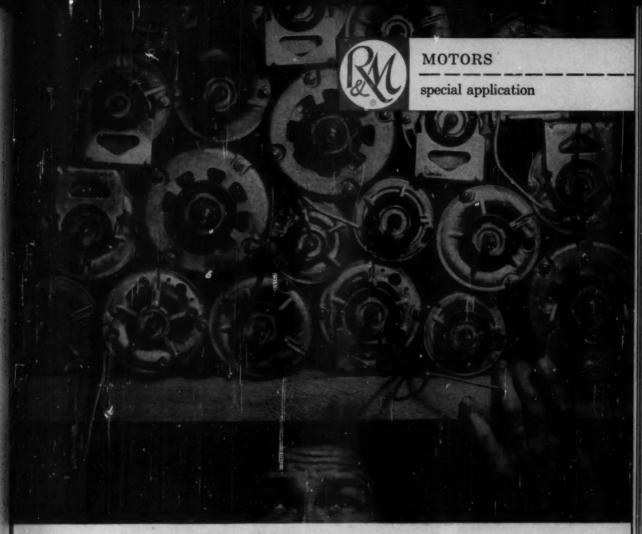


Contains full descriptions of Spirolox and Circolox Rings with complete design information and specifications. Write TODAY!

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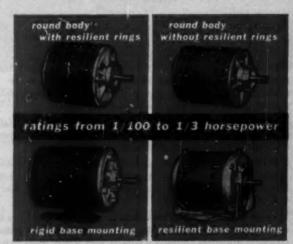
This informative bulletin illustrates and describes in detail Robbins & Myers broad new line of Special Application FHP Motors.

You may select from four frame sizes, sixteen ratings from 1/100

through 1/3 HP, three different pole constructions, three standard mounting arrangements and four electrical types.

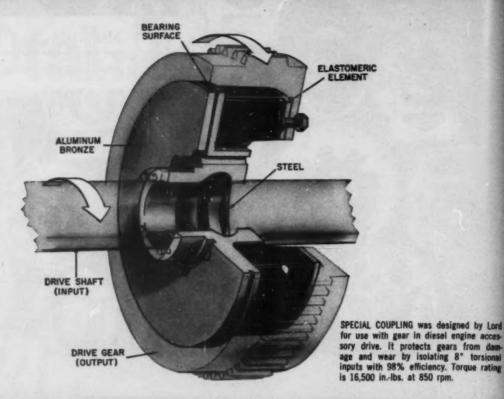
Simple, compact and quiet, these motors offer built-in benefits for your customers, as well as design flexibility for you, where silent operation, limited mounting space and minimum attention are factors.

Also, should your requirements be so special that a custom designed motor is indicated, our expert application engineers, using the most modern electronic computers, can promptly select the optimum design for your special requirements. Write today for your copy of R&M's new bulletin 445-MD



ROBBINS & MYERS, INC., Springfield, Ohlo

Fractional and Integral HP Electric Motors * Electric Hoists and Overhead Traveling Cranes * Mayno Industrial Pumps
Propellair Industrial Fans * R & M-Hunter Fans and Electric Heat * Trade-Wind Range Hoods and Ventilators
Subsidiery companies at: Memphis, Tens., Pice Rivera, Calif., Brantford, Ostario.



DESIGN FOR SMOOTH POWER FLOW

with custom-engineered

Lord Flexible Couplings

Torsionally resilient couplings offer important operating advantages for many power transmission applications. Here's what Lord can give you in a special flexible coupling:

Custom design. Couplings can be designed to meet any specific requirements. They can incorporate any degree of flexibility in one or more modes. Elastomers can be specially compounded to resist extreme temperature and oil environments.

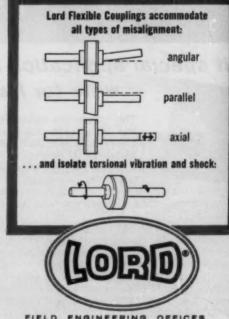
Smooth power flow. Lord Couplings provide constant speed transmission of power with no backlash. Torsional disturbances are efficiently isolated. Varying degrees of misalignment-angular, parallel, axial-can be accommodated simultaneously.

Reliability. Simplified design-no gears, seals, bearings or metal-tometal contact-assures long service life. Resilience protects driven equipment from damaging inputs and extreme overloads.

Special features. Torque capacities from inch-ounces to foot-tons. Permanently quiet operation. Attenuation of shaft-borne noise. No lubrication or maintenance. Minimum size for given horsepower. Optional fail-safe protection.

Package assembly. All these features can be incorporated in a special coupling designed by capable, experienced engineers. Your custom couplings will arrive precision produced, fully tested, ready to do your job.

Get more details from your nearest Lord Field Engineering Office or the Home Office, Erie, Pa.



FIELD ENGINEERING

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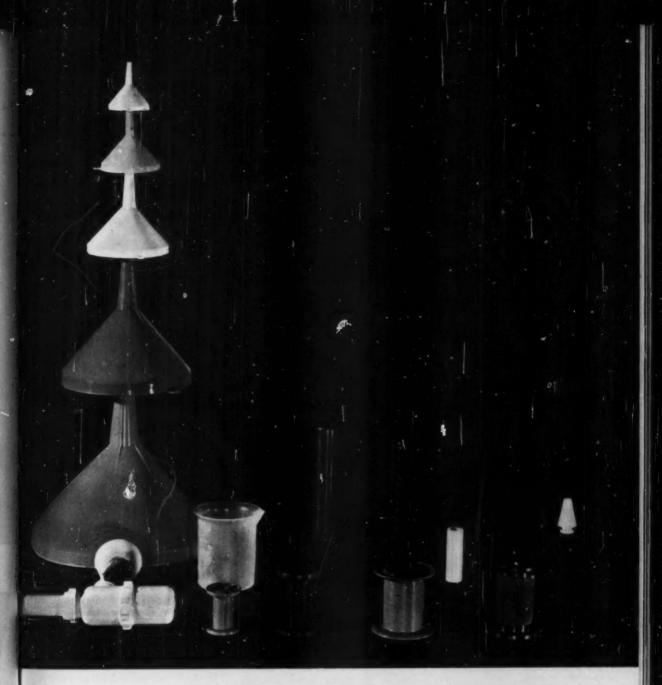
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LORD MANUFACTURING COMPANY . TRIE, PA



Design with POLYPROPYLENE for chemical resistance

Molded parts of MOPLEN polypropylene are being used for industrial, laboratory and hospital equipment because of the material's chemical inertness and other outstanding properties. Its heat distortion point is exceptionally high: not only can it be exposed to boiling water; it can actually be autoclaved for sterilization. MOPLEN has excellent resistance to acid, alkaline and saline solutions. It is unaffected by almost all organic solvents at room temperature and will not absorb oils. The resin is easy to mold; parts are colorful, light in weight, scratch resistant, practically unbreakable. thermoplastic and an original development of Montecatini, is now produced by Novamont in West Virginia. We have the experience to help you adapt this modern material to your product designs. Technical literature and on-the-spot service are available to you through Chemore Corporation, Novamont's and Montecatini's representative in the U.S.-100 East 42nd Street, New York 17, N.Y., YU 6-7575.

MOPLEN Product of MONTECATION



Lamb Thinking on Universal Motors for a unique actuator application

Here's what Lamb Electric designed into these motors:

In order to obtain the required speed and torques and retain the most economical and smallest package, a combination worm and spur gear reduction was used. Also, because of the peculiar space limitations in the application, special design considerations had to be given to the gear ratios and mechanical layout of the package.

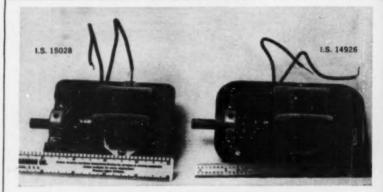
In the initial stages of the design a motor was provided which met the specified speed and torque requirements, however it was soon discovered that this design overheated rapidly. Analysis of the first prototype tests showed that the load cycle had a particularly high torque peak for a very short duration. The motor was designed to supply this amount of torque near its stalled speed. It was found that by taking advantage of the accelerating rate and starting torque of a universal motor, the motor accelerated quickly enough to provide sufficient inertial energy to complete the duty cycle. This enabled the engineers to redesign for a lower peak horsepower output and obtain reasonable operating temperatures, thus producing the minimum size package consistent with the torque and temperature requirements.

The application was such that severe shock loading was encountered at a certain point in the duty cycle. In order to make mechanical construction that would withstand this service, ductile iron castings were furnished and special consideration had to be given to the overhung moment of the motor-gear unit to insure against damage due to vibration. Special bearings had to be used in this service because Brinnelling would occur on normal ball bearings under the severe service encountered. Lubrication is generally a problem under this short duty cycle, therefore, special consideration had to be given to insure that the lubricant protected the wearing surfaces at all times.

This is just a short example of Lamb at work... if you have a motor problem, let us help you with it. This is our business. Write: Lamb Electric, Kent. Ohio, and we'll have a Lamb District Engineer call on you to open preliminary discussion of your problem.



THE LATEST DESIGN NEWS ON FHP MOTORS FROM LAMB ELECTRIC



New Lamb motors represent advancements in small universal motor design

New design combines high quality and long life with relatively low manufacturing costs

Initially, the I.S. 15028 and companion motor I.S. 14926 were designed for powering rug agitators on a well-known line of canister-type vacuum cleaners. Now, many future appliance applications have been visualized. The range of ratings possible with this design (as high as 1/10 H.P. at 12000 RPM or ½ H.P. at 15000 RPM) makes this motor ideally suited for many motor powered domestic applications.

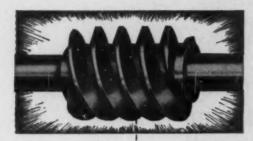
Some of the novel features of this motor project were:

The housing is a one-piece simple phenolic molding. It is designed in a half shell form in such a way that the motor bearings and other components can be held in accurate relationship with an unmachined housing.

The half shell housing of the motor is designed to mate with a corresponding opening on the customer's device to complete the motor enclosure. When a free standing motor is desired, this upper enclosure can be a simple stamping.

The I.S. 15028 motor was designed with a sleeve and a ball bearing. However, on other versions of this motor, either sleeve or ball bearings or a combination can be used at only a low tooling expense through use of easily interchanged inserts in the housing mold cavity.

The sleeve bearing as used in this design takes full advantage of the economics possible with the half shell motor design. The full-spherical shaped self-aligning type of sintered bearing is mounted directly in a semi-spherical recess in the housing. A spring clip presses against the top of the bearing to secure it in place while at the same time permitting self-alignment movement. Life-time lubrication is provided by an oil soaked felt strip located beneath the bearing. There are other features worth noting in this unique design problem. For further particulars, write to Lamb Electric Co., Kent, Ohio.



Cleveland's Master worm principle enables exact mating of any replacement worm or gear...

if ever regained!

These original Master Worms —our "common denominator" of quality—as well as all hobs for each size and ratio of Cleveland worm gearing are individually produced in our tool room to extremely close tolerances. Furthermore, each hob is painstakingly checked against the master worm—as are all Cleveland production worms and gears.

It's never necessary to replace Cleveland worms and gears in sets. Because, each Cleveland production worm or gear is a duplicate of each other.

A new gear will always mate exactly with an old worm and vice versa. Cleveland's Master Worms are never destroyed but kept in perpetual stock—always available at a moment's notice. So, you're guaranteed perfectly fitting worms or gears for service and maintenance requirements.

Get the complete story from your Cleveland Representative, today. Or, write us direct for free Bulletin No. 405—it gives full engineering information.

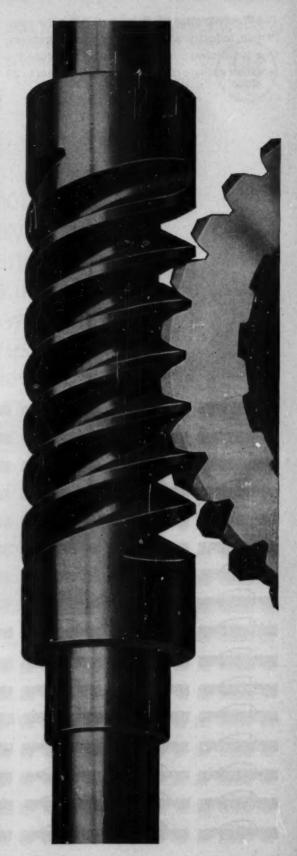
Cleveland Worm & Gear Division

Eaton Manufacturing Company
3249 East 80th Street • Cleveland 4, Ohio



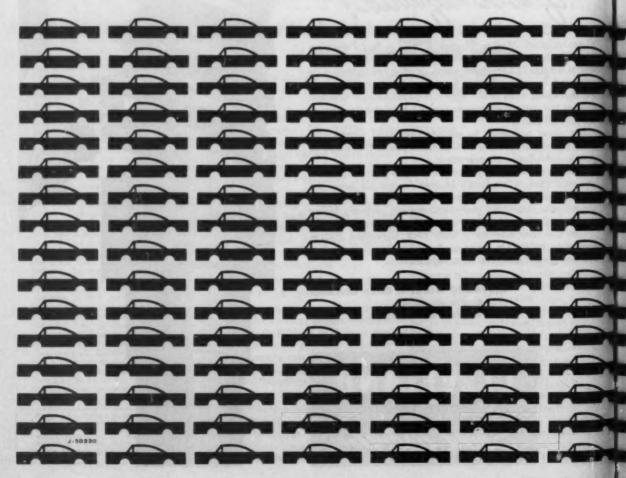
CLEVELAND

Speed Reducers



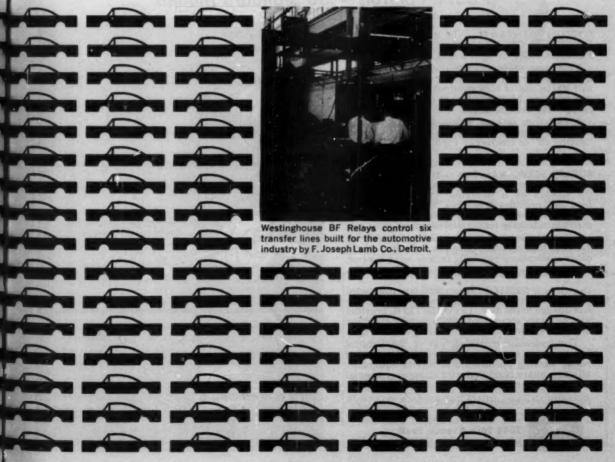
The Westinghouse BF Relay is helping the automotive industry solve its floor space problem. One automotive customer was able to reduce the length of a single control panel from 36 feet to 22

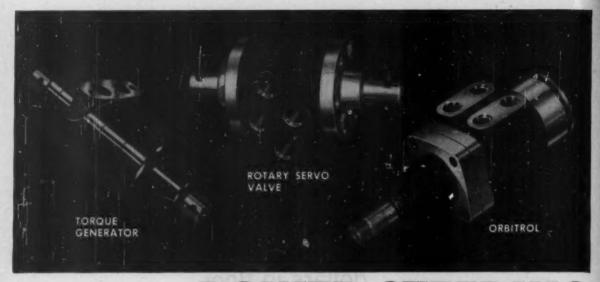
feet. Another eliminated one of three panels. The Westinghouse BF Relay is a new concept in relay design tailored to space-saving needs of automation. As many as four BF Relays fit in the space of



one old style relay. Besides being small, performance excels other machine tool relays. Learn how it can help you gain valuable floor space for more productive uses. Contact your Westinghouse sales engineer or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pennsylvania. You can be sure... if it's Westinghouse

Automotive industry saving thousands of dollars in floor space with the new Westinghouse BF Relay





Char-Lynn POWER STEERING

Now available for all Types of Vehicles

3 Basic Controls • 30 Standard Models

TORQUE GENERATOR is used to furnish POWERED OPERATION or TORQUE AMPLIFICATION to mechanical steering systems.

This remarkable steering control contains both a Servo Valve and Orbit Motor which delivers up to 1,100 in. lbs. of torque output at 1,000 PSI system pressure. Manual effort at the steering wheel is approximately 30 in. lbs.

Direct thru linkage within the unit provides means for manual steering of the vehicle during "engine off" or emergency conditions.

ROTARY SERVO VALVE is a remote control for steering systems where it is desirable to actuate the linkage by a hydraulic cylinder. Pressure feed-back provides "load feel" at the input shaft proportional to operating pressure. Also contains direct thru linkage for manual steering.

Although designed primarily for power steering systems, this versatile valve has unlimited use in other applications requiring remote servo control.

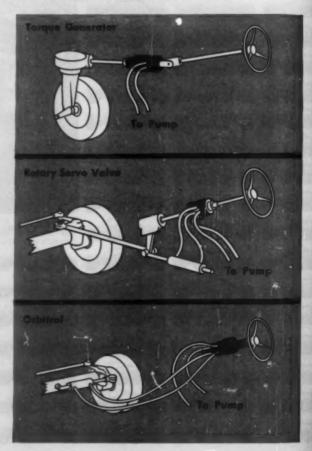
The all new ORBITROL is a completely integrated fluid steering control that eliminates any mechanical linkage to the axle. The ORBITROL provides remote rotary servo control with sensory direction and delivery measurement within the same unit.

The hydraulic motor section of the Orbitrol functions as a metering device during normal power steering operation and reverts automatically to a rotary hand-pump for emergency manual control.

For complete information write:



Char-Lynn Co., Dept. P-3 2843 26th Avenue South Minneapolis 6, Minnesota



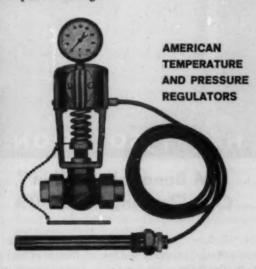
specify accurate instruments

TO MATCH THE QUALITY OF YOUR PRODUCTS

The quality of many a product is complemented by quality instrumentation. That is why many new machines come equipped with American Thermometers, Ashcroft Pressure Gauges, and American Temperature and Pressure Regulators.

We produce these temperature and pressure indicating and regulating devices in great variety for application by original equipment manufacturers. The reliable service these instruments give is also appreciated wherever industry must measure and regulate process temperatures and pressures.

Complete specifications available on request. Mail the coupon for catalogs.



Fastest response is provided by these American Regulators because: 1) the stem can't bind and retard valve action; 2) a bellows seals off the stem and makes practical a non-leaking packless valve. They are self-operated – need no outside power to control temperatures and pressures. Maximum use is made of stainless steel and bronze. Regulator sizes: For temperature—½" to 4". For pressure—½" to 2". Operational ranges: temperatures as low as -15°F. to 50°F.; as high as 240°F. to 340°F. Pressure—250 lb. design.

MANNING, MAXWELL & MOORE, INC.



Gauge and Instrument Division • Stratford, Connecticut Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario AMERICAN THERMOMETERS

Two outstanding characteristics of these American Bi-Metal Thermometers are 1) precision manufacture to assure sustained accuracy; 2) the unique Maxivision® dial that eliminates parallax errors. Stainless steel construction safeguards against corrosion. Hermetically-sealed models meet the severest service conditions. Dial sizes: 2", 3", and 5". Temperature ranges to suit the application. All types of connections. Stems to 24"; wells to fit all lengths.



These Ashcroft Steel Case Gauges are used on many portable compressors, pumps, and regular pressure lines. They are Bourdon-tube-equipped gauges in pressure, vacuum, and compound types. Brass movement is of precision design. Special heavy-duty movements also available. Pressures range from 15 psi to 600 psi. Dial sizes: 2", 2½", and 3½". Pulsation dampeners, gauge savers, needle valves, and other accessories available. Make your selections to fit the application. Other gauges in the Ashcroft line include Duragauge, Maxisafe, pneumatic receiver, recording, chemical, test gauges, and master reference gauges.

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Designers think of R/M first for asbestos, rubber,



Molasses Dairy Feeds Clog Scale Openings

Stainless steel interiors of automatic feed weighing scales have long provided good service for users of Richardson Scales for weighing molasses content feeds. But as molasses content increased, so did the time and effort required for cleaning.

Usually twice-a-day cleaning sufficed. But the higher the molasses content, the faster the feed adhered and built up on all platework. Downtime for cleaning went even higher.

Now Richardson Scale Company uses R/M "Teflon" sheets wherever molasses feed makes contact with the scales. Field experience proves that now scales never clog, cleaning requires only a moist sponge instead of a metal scraper and only 1/10 as much time as before. Problem solving is a natural



R/M Bondable "Teflon"* Cuts Cleaning Time 90%

for "Teflon" in applications which utilize its non-adhesive property and low coefficient of friction. Talk to R/M—headquarters for "Teflon" rods, sheets, tapes, hose, machined parts, with or without bondable surfaces. Write for information or call your nearest R/M district office.

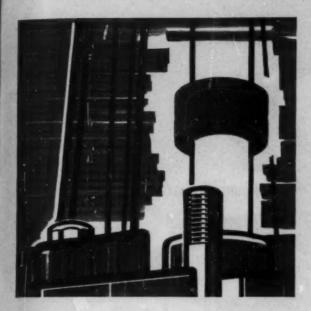
*Registered TM for Du Pont fluorocarbon resins

PLASTICS



For a copy of this booklet, full of information on R/M's complete line of "Teflon" Products, write Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

sintered metal, and engineered plastic products



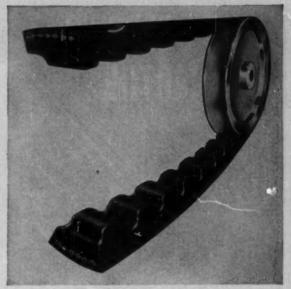
R/M CAPABILITY PRODUCES VALVE STEM PACKING of low volume loss at up to 1150°F

Low volume loss is a basic requirement of high-temperature valve stem packings. Reliable sealing characteristics are assured when valves are packed with R/M No. 325 because total volume loss is less than 5%. R/M No. 325 high-temperature valve stem packing is free of the organic materials that make other packings burn out and require much adjustment. Contains AAA grade Inconel-wire-inserted asbestos yarns braided over a plastic core that will not fuse. R/M No. 325 offers an extra dividend in that it contains a corrosion-resistant inhibitor that protects against valve stem pitting after valves are hydrostatically tested and stored.

There are R/M valve stem packings for your every department, each offering superior advantages. Let us know your requirements and depend on us to meet them.



For complete information on R/M Mechanical Packings and Gasket Materials, write for new Catalog P-100. Packing Division, Raybestos-Manhattan, Inc., Passaic, N.J.



R/M CX MOLDED V-BELT OUTLASTS—AND OUTPERFORMS OTHER BELTS 8 to 1 . . .

Use R/M CX Molded V-Belts wherever more flexibility and ruggedness with quieter, cooler vibration-free operation are required.

- Fully Molded—Fully Jacketed
- No Cut Notches—No Exposed Sides
- Holds Shape and Effective Length Without Stretch
- Vibration-Free-No Slap, No Hum, No Buzz
- No Ply Separation—No Flex-Cracking
- Ideal for Small Sheave Diameters, Short Centers, High Speeds

It's the only notched V-belt of its kind made. Let R/M specialists work with you on V-belts, rubber hose, transmission or conveyor belting, molded or extruded parts.



Write today for Bulletin M220 and booklet shown; full details on a wide variety of industrial rubber products. Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N.J.

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • Paramount, Calif. • No. Charleston, S.C. Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada





In designing for air operation, the engineer can choose the method of valving he prefers—and still have all the advantages of integral valve and cylinder construction.

Six different built-in valve arrangements give the engineer every latitude in pneumatic design.

If he prefers to use 8-12 volt electrical control with its simplified wiring, Bellows has it. If he prefers to use 115 volt control and JIC standards, Bellows has it. If he requires low or high voltage explosion-proof control, Bellows has it. Should his design require full pneumatic control, Bellows has it. Or should he

wish to control his pneumatic circuits manually or through mechanical linkage or cams, Bellows has it.

Unlike conventional air cylinders which require separate remote directional and speed control valves and dual piping, the Bellows Air Motor is a complete power unit with directional valve and dual speed control valves built-in as an integral part of the unit. Only one air connection, which can be made with flexible hose, is required.

Integral valve and cylinder construction means quick response, more positive response, more precise control and more economical operation.

The Bellows Air Motor is made in five bore sizes: 1¼", 1¾", 2½", 3%", and 4½", and in any stroke length.

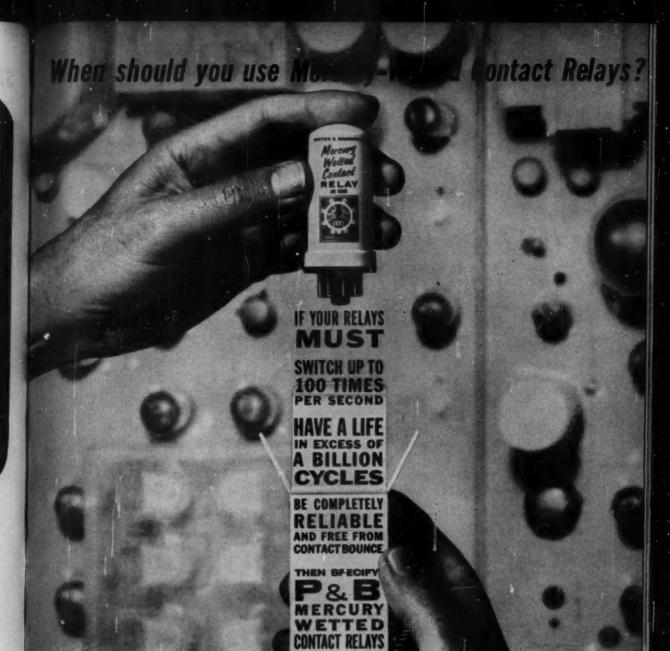
WRITE FOR THIS BULLETIN TODAY!



Four-color, 20-page bulletin describes the complete line of Bellows Air Motors. Free on request. Address Dept. MD-1061, The Bellows Co., Akron 9, Ohio.

Bellows - Valvair

DIVISIONS OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)



An unusual combination of advantages found only in mercury-wetted relays has led many design engineers to specify them for tough switching jobs. Here are but 3 typical characteristics of our JM series:

RELIABILITY. Sealed-in-glass mercury contacts are renewed with every operation. Won't pit or weld. Make or break is positive . . . every time. No bounce, no chatter. Signals ranging from a few micro amps to 5 amps are switched with singular consistency.

LONG LIFE. Think in terms of billions of operations when considering JM series relays. Proper application, of course, is a requisite.

SPEED. Operate time is just less than 3 milliseconds using 2 watts of power. Release time is about 3.2 milliseconds. Thus, relays can be driven 100 times

If your project calls for exceptional relay performance, perhaps the answer lies in our JM Mercury-Wetted contact relay.

JM SERIES ENGINEERING DATA

Contact Rating:

5 amperes maximum 500 volt maximum

250 volt-amp max, with required contact protection.

Contact Configuration: Each capsule SPDT. Combination of capsules in on enclosure can form DPDT, 3PDT, 4PDT. (All Form D.)

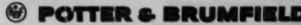
Plug-in or hook solder; 8, 11, 14, or 20-pin headers.

Coll Resistance:

2 to 58,000 ohms.

More information? Write today for free catalogu





Who else wants to save \$100,000 this year?

How the Revere Technical Advisory Service Showed a Metal User the Way to Profit-Protecting Economies — and can do the same for you!

A leading manufacturer—you'd recognize the name immediately—is a heavy user of copper and its alloys. It buys sheet, strip, tube, rod—by the hundreds of tons. Recently, this company invited the Revere Technical Advisory Service to inspect its operations, study its metals needs, analyze its buying practices and look into its specifications. The Revere people were actually treated as members of the crew at the company's plants; nothing pertinent was kept secret, no knowledge hidden.

The result? Recommendations all down the line on every phase of copper and copper alloy procurement and use—and production savings made possible in every area. The Revere Technical Advisor actually showed the way to an astonishing potential saving . . . well over \$100,000 yearly!

Naturally, not every company can expect such huge savings. Too many variables enter in. But if detailed knowledge of metals, their manufacture and their uses can be applied to your product and your production, the Revere Technical Advisors are at your service. These are the men who know non-ferrous metals best—and many other metals equally well. They are ready to serve you—now.

You can reach the Revere Technical Advisory Service simply by calling or writing the Revere Office nearest you. If you are interested in a cooperative program of this kind and in discussing your metals procedures fully—in confidence—call Revere today. You will find that you have taken the first step toward profit-protecting economies. No obligation, of course.



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BIG PICTURE-100 TIMES ACTUAL SIZE-

checks ball bearing geometry

BCA engineers take a close, "big" look at the configuration of inner and outer rings of ball bearings with this contour projector. It magnifies profiles up to 100 times actual size—makes possible extremely accurate measurements and control of all geometric characteristics of raceway rings.

This contour projector provides essential information for BCA research in developing new and modified bearing designs. It also evaluates the production performance of precision tools and machine set-ups by checking the profiles of production raceway rings against precise design specifications. This device is only one of many BCA quality control measures that help assure uniformly high ball bearing quality.

New BCA laboratory facilities also include a variety of specially designed testing machines that simulate actual or exaggerated operating conditions. On this equipment, bearings are studied under exact operating conditions of the customer's application . . . and tested to exceed his specifications.

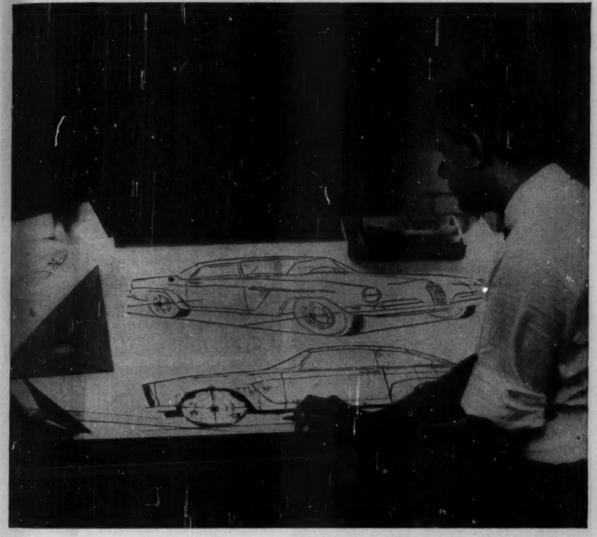
BCA ball bearings for original equipment as well as replacement use are made in a complete range of types and sizes. They serve practically every kind of industry . . . automotive, machine tool, construction and agricultural equipment, to name a few. For complete information, for experienced engineering counsel on bearing applications, contact: Bearings Company of America, Division of Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.

BEARINGS COMPANY
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WHAT'S NEWS IN RUBBER



In design after design...the big switch is to BUTYL!

Automotive engineers have discovered that Enjay Butyl rubber is one of the best ways to improve car performance. Now all U.S. cars contain parts made from Enjay Butyl...parts such as weatherstripping, body mounts, engine mounts, radiator hose, accelerator pedals, and many more. Engineers specify Enjay Butyl rubber because...

- Butyl resists weathering
- •Butyl deadens noise and vibration
- Butyl absorbs shock
- Butyl beats the heat
- •Butyl resists tear, flex and abrasion

Enjay is always ready to help manufacturers build the extra performance of Butyl into their cars. For more

information, contact Enjay's Detroit Area Office, 17360 West Eight Mile Road, Southfield, Mich. Phone KEnwood 2-7113.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

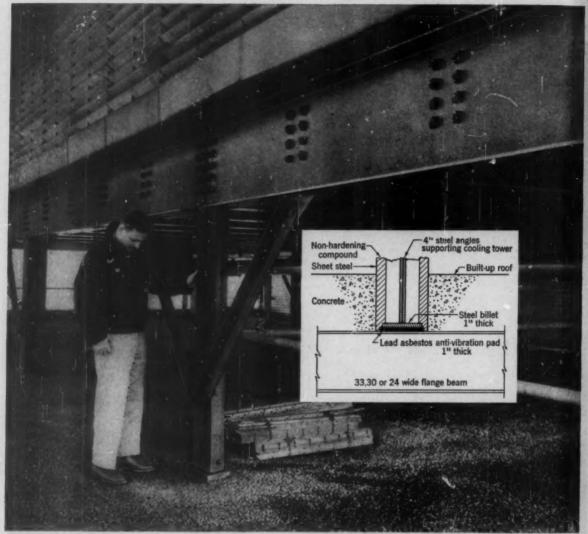
ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

October 12, 1961

Circle 273 on Page 19





Consulting Engineers: Weinberger, Frieman, Leichtman & Quina Architects: Sylvan Bien & Robert L. Bien

Machine vibration tamed with feet of LEAD

Give machinery in motion lead asbestos pads to stand upon, and a designer may have noise and vibration problems quickly under control. An example is the air-conditioning unitatop the new 35-story skyscraper at 575 Lexington Avenue, New York. Here lead asbestos pads just one inch thick, placed between the cooling tower and the building's structural steel, cushion the wide spectrum of noise and vibration created by the 205,000-pound unit and confine it to the tower.

This use of lead asbestos also saved

considerable time and money. Pads and supporting columns for the tower were positioned while major steel work was in progress. It was not necessary, as with usual methods, to wait until the concrete roof slab had been poured.

If you have a vibration or noise problem, perhaps the solution lies in one of the many forms of lead. We'd be more than pleased to help you find it. Just write to: Lead Industries Association, 292 Madison Ave., New York 17, N. Y.



DOT. NYLON PUSH-IN NUT

- Non-corroding
- Electrical insulator
- High pull-out resistance
- Straight legs won't distort thin, soft materials

This versatile fastening device snaps into place under finger pressure alone. Its straight legs permit easy insertion in square, punched holes while the tapered screw hole forces the legs apart when screw is inserted and ensures maximum pull-out resistance. Burrs do not impede the nut or prevent proper seating.

Ideal for use in virtually any type of thin-walled structure of sheet metal or plastic, the DOT Push-in Nut does not chip enamel surfaces, locks tightly without distorting the edges of the hole, resists vibration and serves as an excellent electrical and thermal insulator.

Suitable for use with #8 or #10 screws...locks in holes from .275" to .292" square...application thickness range: .030" to .060". Spacer type available with ½" dia. head from ½" to 13/12" length in increments of ½". Other types available in various sizes, round or square-headed, from ½" to ½" thick.

Engineering details and price information available on request.

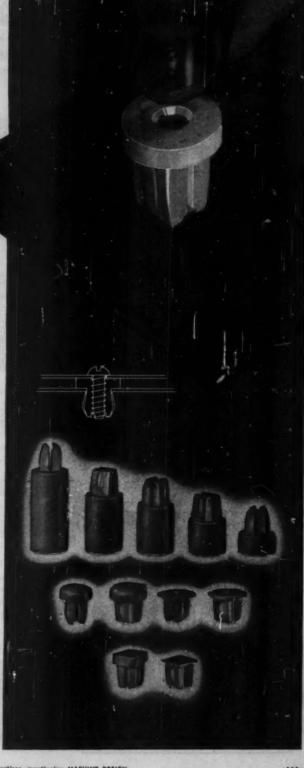
CARR FASTENER COMPANY

Division of UNITED-CARR FASTENER CORPORATION

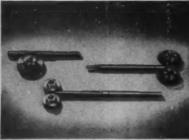
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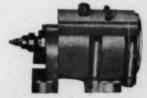
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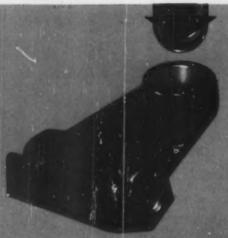
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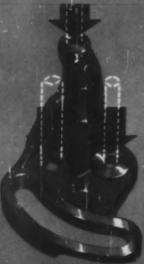




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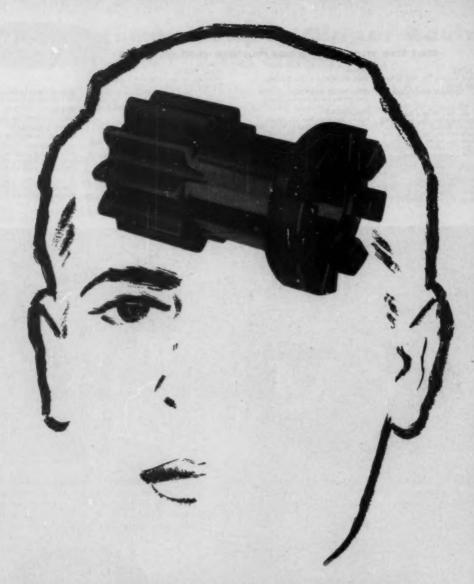
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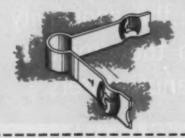
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MASONITE PANEL CLIP retains back panel of a TV cabinet, may be applied to many types of covers, panels, access doors, and displays. "U" section locks by hand on panel edge, spring leg snaps over flange of metal cabinet. This Speed CLIP® fastener eliminated eight drilling and screw operations, cut assembly time in half, substantially reduced materials handling for TV manufacturer.



WIND CORD CLIP has wide usage wherever fabric must be fastened to metal panels. Dart-type, self-anchoring tabs snap into wire weave and mounting holes, draw gripping corners down tight. Assembly requires only thumb pressure. Allows smoother fastening with fewer parts. First used for fastening insulation cord in car doors.



ANGLE BRACKET fastens mitered corners of extruded aluminum channel sections, replaces awkward tapped angle bracket. One of a large line of Speed Nut angle fasteners. Relieved corners allow for heavy burrs on sawed edges, provide flexibility to offset hole misalignment. Originally designed for storm sash, these fasteners can also be used in picture framing, metal doors and windows, cabinets and display cases.



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SPACER SPEED NUT fastener eliminates lockwashers, riveting, welding, staking, clinching, provides clearance for counterpunched holes. Fastener is vibration-proof, self-retaining and easily removable. Built-in spacing legs eliminate separate spacers, cutting parts handling and inventory, lowering assembly time and costs. Spacer Speed Nut fasteners are available in a wide range of sizes.



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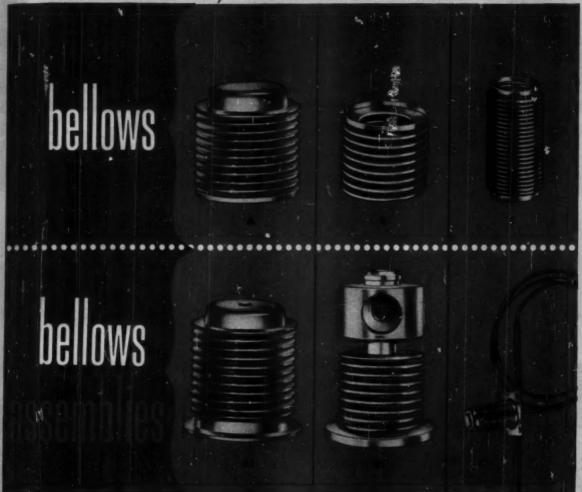
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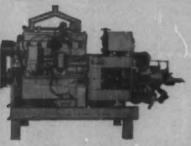
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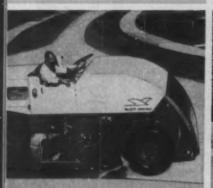


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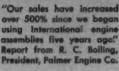






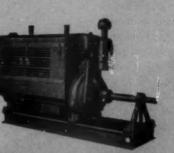


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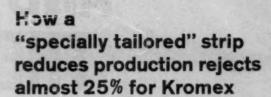
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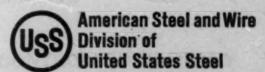


Kromex, Inc., Cleveland, Ohio, turns out a complete line of pantry ware, but they were having trouble with a square, mirror-finish chromiumplated cake cover that was made with a single deep draw. Rejection rate was a stunning 25%. They first tried a No. 3 finish for this application, but because of the very deep draw and the dense and smooth surface, satisfactory lubrication was near impossible. The result: Excessive draw marks and breakage. A regular No. 2 finish was then tried. The draw was successful. But buffing and finishing costs were prohibitive for this application.

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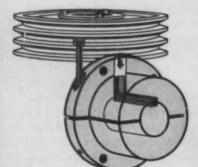
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The Golden Clamp Screw at the left is an exclusive Worthington feature that locates and locks the hub securely on the shaft, permitting you to tighten the set screw without distorting the hub. And note that the two-piece hub-and-rim design simplifies installation. You install one piece at a time—or change sheaves without disturbing the kub or affecting the alignment.

The Golden Screw on the right is the set screw that turns down to lock the key securely in place. It prevents potentially damaging key drift. There's no extra cost for the set screw but it is worth its weight in gold for the safety it provides.

These Worthington hubs are standard in three major Worthington drive systems: the new,







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money-saving, more compact Multi-Wedge Drive; the standard Multi-V Drive and the Positive Drive. Ask for one or more of the "how-to-figure-it" design manuals shown here. Your local Worthington distributor stocks these products. He'n listed in the Yellow Pages. Or write Worthington Corporation, Section 79-42, Oil City, Pennsylvania.



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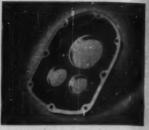
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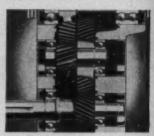
Dodge Manufacturing Corporation, 3300 Union St., Mishawaka, Ind.



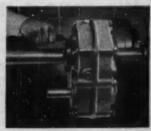
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AGMA rated helical gears. Soft cores withstand shock; hardened surfaces defy wear. Teeth are crown shaved.



Gears are located between bearings and carry their loads without strain. Longer life, higher efficiency.



Unit slides completely onto shaft and locks on both sides of housing. This baby stays put—runs truer longer.

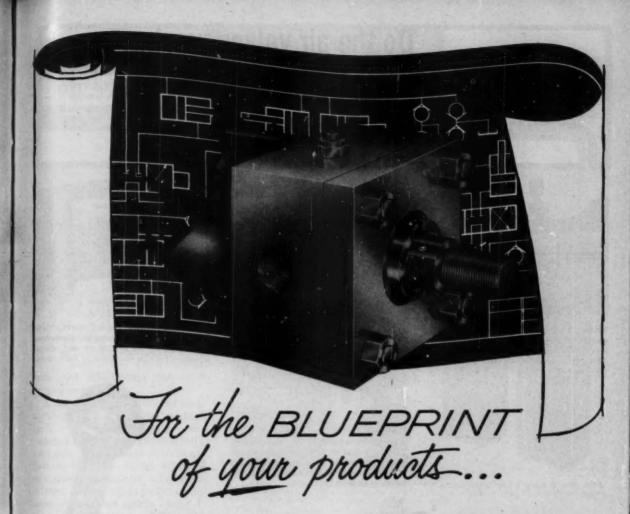
The Products with the Pluses...

DODGE

of Mishawaka, Ind.



CALL THE TRANSMISSIONEER, your local Dodge Distributor. Look under "Dodge Transmissioneer" in the white pages of your phone book. Factory trained by Dodge, he can give you valuable assistance.



SPECIFY T-J CYLINDERS ... FOR YOUR POWER DRIVE DESIGN • APPLICATION OR REPLACEMENT MAINTENANCE

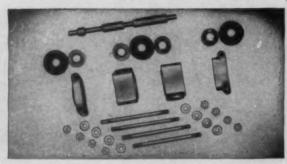
From its blueprint stage to its maintenance engineering requirement sheet, your product will assure MORE power drive precision and service, if T-J cylinders are specified. T-J's complete line too, from the

Spacemaker to the new replaceable Squair Head, can be the enswer to any power problem. Write or call The Tomkins-Johnson Company, 2425 W. Michigan Ave., Jackson, Michigan, today!



Do the air valves you buy include these quality features?







SEAL—Exclusive, triple-supported seals permit interference fit of spool for extratight closure with minimum wear. Usual damage to conventional "O" rings by moving spool is eliminated.

SIMPLICITY—Uncomplicated parts mean long life and easy servicing. Common parts are used extensively to simplify stocking or repair.

FLEXIBILITY—Modular Construction.
Operators, mounting holes and ports may
be independently rotated in 90° steps.
Operator may be on either or both ends.



if not, the chances are your maintenance costs are higher than necessary. For more information about quality Fluid Circuitry Controls for trouble-free automation, ask for Catalog A4-75.01.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.



WESTINGHOUSE AIR BRAKE COMPANY

INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA



Versatile equipment studded with outlets

Plugmold built into electronic racks makes power accessible wherever it may be used

Typical of original equipment that needs available outlets, amplifier and power supply racks for large sound systems have added versatility with Plugmold. These multioutlet assemblies allow almost unlimited possibilities for outlet arrangements.

Almost any arrangement of Plugmold can be accomplished: a single strip (far right), parallel runs (center), mounted horizontally, vertically, around corners, or in any fashion to match configurations of equipment. In both of these applications, factory wired sections were used, with duplex outlets spaced 6" on centers. Other standard outlet spacings, with duplex or grounding outlets, 2-wire or 3-wire, are also available. Other Plugmold types permit you to place many other kinds of devices in any position desired. For example, fuses, circuit breakers, multi-prong jacks, etc., can be installed in the raceway. Or, portable power strips can be made with provision for easy connect and disconnect.

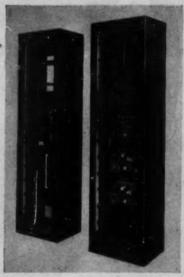
On your work bench too

Designers often use electrical/electronic equipment in their work. Plugmold is an ideal way to wire your work bench with all the outlets you need — the ultimate in convenient efficiency.

Standard Plugmold types are stocked by electrical wholesalers everywhere. Wiremold welcomes the chance to assist in developing special assemblies.



At left, two rows of Plugmoid provide outlets on electronic rack. At right, technicians' work benches have convenience outlets for equipment.



Plugmold outlet strips make a neet power source in back of amplifier and power supply racks.

Flexible duct resists abrasion -

Even exhausts diamond dust

Wiremold's Type 8R duct combines the benefits of flexibility with rugged resistance to abrasion.

Designed to handle such abrasives as diamond dust, glass cuttings, wood chips, pulverized or granular materials, the duct is made of Nylon fabric coated with heavy, abrasion resistant neoprene. This fabric locks mechanically to a flat metal spiral (see cutaway) making the duct firm and rugged, yet completely flexible.

The duct can be assembled and secured in seconds. Fasten it to connector by securing 2 or 3 drill screws through the flat spiral and connector.

Six standard duct types cover a wide range of uses. Special shapes (e.g., square, oval) can also be furnished.



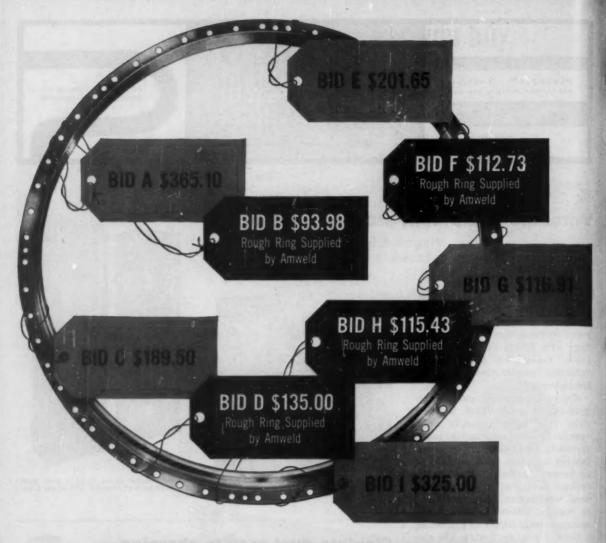
Exhaust duct on diamond dust collector. Cutaway shows duct's unique mechanical locking construction.

SEND FOR LITERATURE

Air Duct Plugmold



Circle 293 on Page 19 A Circle 294 on Page 19 A



FOUR OUT OF FIVE LOW BIDDERS BASE QUOTES ON ROUGH RINGS BY AMWELD

Early this year nine companies submitted manufacturing bids ranging from \$93.98 to \$365.10 on this circular jet engine turbine shroud. Four out of the five lowest bidders submitted their finished shroud quotation based on rough rings, flash butt-welded, furnished by Amweld.

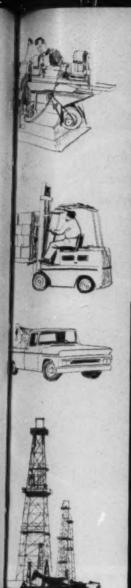
Whether you're bidding for military or commercial business, Amweld flash butt-welded rings can save you money—can help you get more business. The quality of Amweld rings

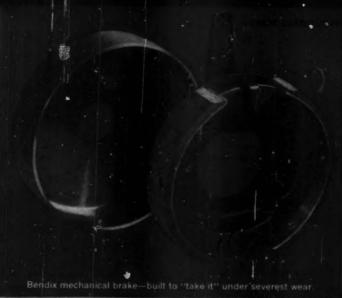
has been proved repeatedly in jet engines and missiles. The cost reduction opportunity presented by Amweld rings enabled Amweld customers to save over \$1,000,000 on circular components and assemblies last year alone.

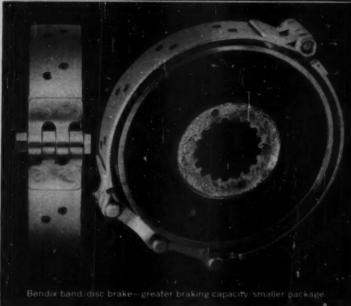
Investigate now! Let Amweld review your circular component requirements and figure actual cost savings to you with Amweld flash butt-welded rings. Send your drawings and specifications today. The American Welding & Manufacturing Co., 903 Dietz Road, Warren, Ohio.



THE AMERICAN WELDING & MANUFACTURING CO., WARREN, OHIO





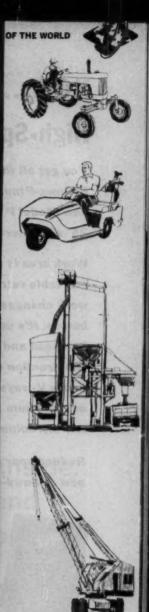




Practically any application you can think of—golf cart, power saw, tractor, oil rig, steam shovel—can use the benefits of Bendix small, multi-purpose brakes. The Bendix® band/disc brake gives greater torque capacity while reducing brake size. It provides maximum lining area in minimum space; permits rapid heat dissipation. The small mechanical brake is economical, easy to install and adjust, requires little maintenance. Light and compact, it packs man-sized power in 4 lbs. of brake and drum. Available in complete range of sizes. These small, multi-purpose brakes could be the answers you've looked for. Write us at South Bend, Indiana, for sizes and actuations available.

Bendix Automotive Products Division

Circle 296 on Page 19



NOW...A Larger Capacity FELLOWS-PFAUTER High-Speed Hobbing Machine...The P 630

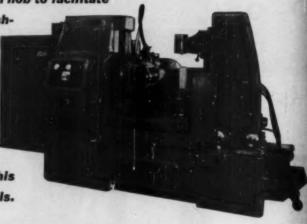
You get all the advanced-design features of the production-proved P 400 Fellows-Pfauter hobbing machine — plus extra work capacity — with this new Mcdel P 630. Takes work up to 25" diameter. Maximum face width at 25" diameter is 161/4". Maximum diametral pitch in steel is 3.

Work area is readily accessible for setup and loading, and table retracts automatically from hob to facilitate

work changes. Hob shifting is by push-

button. It's solid too, with rugged hob head and double wall construction column and bed, and heavy V-ways. Table is as large as maximum workpiece diameter — work column of massive design.

Reduce your production costs with this new Fellows-Pfauter. Write for details.



NEW... Dictionary of Change-Gear Combinations

"Fellows-Pfauter Change Gear Tables" by F. Becher and A. Koerner eliminates tedious calculations and trial-and-error methods. Gives combinations for more than 26,000 ratios carried to six decimal places

from .100,000 to 1.000,000, with greatest step approximately .00005. Gears in range of 18 to 80 teeth mainly used. Examples are given. Only \$8.00. Order from THE FELLOWS GEAR SHAPER COMPANY, 78 River St., Springfield, Vermont, U.S.A.

THE FELLOWS GEAR SHAPER COMPANY 78 River Street, Springfield, Vermont, U.S.A.

Branch Offices:

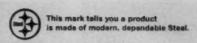
1048 North Woodward Ave., Royal Oak, Mich. 150 West Pleasant Ave., Maywood, N. J. 5835 West North Avenue, Chicago 39 6214 West Manchester Ave., Los Angeles 45

THE PRECISION LINE

PO

Fellows

Gear Production Equipment





35

n

Smooth...inside, outside...and accurate, too!

For a very fundamental reason, more and more Engineers, Designers and Purchasing Agents are specifying USS National Electric Resistance Welded Steel Mechanical Tubing—it saves money.

Dimensional accuracy and closely controlled mechanical properties insure consistency—consistently low machining losses, uniform strength, low fabrication costs and high torsion resistance—and the tubing is smooth inside and outside.

Whether your tubing app'ication requires the dependability for a load-carrying member or the surface smoothness quality for a hydraulic cylinder, USS National Electric Welded Mechanical Tubing must be your first consideration.

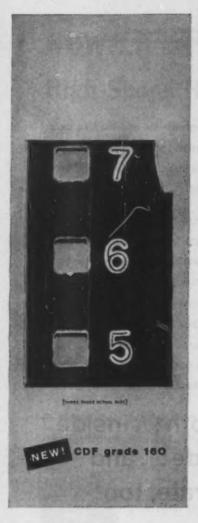
USS National Electric Welded Mechanical Steel Tubing is available in a wide range of cold drawn or hot rolled sizes from as small as %" x .028" to as large as 5½" x .250". Your National Tube Distributors throughout the country will gladly show you how tubing can reduce your costs. See your USS National Tube Distributor.

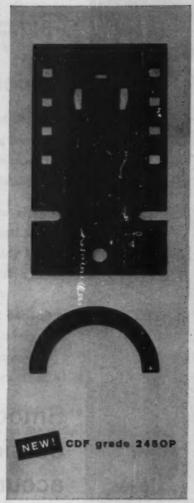
USS and National are registered trademarks

National Tube Division of United States Steel



Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division
United States Steel Export Company, New York







three outstanding new laminates!

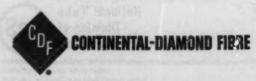
High legibility letters, numbers or symbols can be stamped on this new warm punch, paper phenolic grade in the same die used for blanking and piercing! No separate operation is necessary . . . no registration problems. Markings are permanent and in sharp contrast. Ideal for capacitor caps, terminal boards, panels, spacers, coil ends, socket bases. Meets NEMA X and XP requirements.

Economical paper phenolic grade 2450P can be punched warm and has improved mechanical strength and lower moisture absorption properties. It is designed especially for mechanical and low voltage electrical insulation applications such as connector blocks, coil and bobbin ends, washers, plug and socket bases. Meets NEMA X and XP requirements.

Excellent wet electrical and other improved properties make this new copper-clad glass fabric Teflon* laminate ideal for radar insulation, missile antennas, critical computer applications. Circuits based on this grade will show minimum drift under varying temperature and humidity. Also available without copper for such uses as high frequency insulation in wave guides.

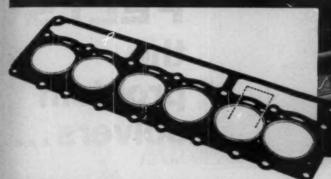
These are the newest materials of CDF research and engineering, developed to give you outstanding performance at minimum cost. Your inquiry is welcomed.

*Du Post trademark



CONTINENTAL-DIAMOND FIBRE CORPORATION, NEWARK, DELAWARE . A SUBSIDIARY OF THE - COMPANY

RAMBLER ALUMINUM SIX sealed with Victocor



This optional choice engine in 1961 models—America's first die-cast Aluminum Six—is a powerful friend-maker for Rambler. It saves 80 pounds weight—resulting in easier car handling with excellent performance and satisfying economy.

A VICTOCOR cylinder-head gasket seals this fine engine. VICTOCOR's superior compressible and resilient sealing properties are combined with a stainless steel bottom layer that provides maximum heat and corrosion resistance.

VICTOCOR's exclusive metal core-Asbestopac* construction dissipates heat build-up...reduces torque loss... and maintains dimensional stability. The Asbestopac component retains all coolants.

*Synthetic rubber-asbestos sheet packing

VICTOCOR CHARACTERISTICS

Low Torque Loss • High Heat Resistance • High Corrosion Resistance • High Crush Resistance • High Dimensional Stability • Various Gauges Available—as thin as .030-.035

Cross section above shows how thin steel core is die-formed with continuous projections (800 per sq. in.) alternating in each face. Victocor sealing element layers, top and bottom, are bonded simultaneously, mechanically and chemically, into integral structure with core. Deep penetration of core projections increases steelilty and heat conductivity. The stainless steel bottom of gasket is formed into the combustion chamber openings.

WRITE FOR CATALOG NO. 505A

Available in standard type and modified structures, VICTOCOR gaskets have wide adaptability for automotive and industrial machinery sealing. Consult your Victor Field Engineer, or write on your business letterhead for catalog on VICTOCOR and other superior packings. Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Illinois. Canadian Plant: St. Thomas, Ontario.





VICTOR

Bealing Products Exclusively

GASKETS

PACKINGS

· OIL SEALS

MECHANICAL SEALS

October 12, 1961

Circle 299 on Page 19

135



FELTS the problem solvers...

Our new FREE brochure describes these multi-functional materials whose more than 850 types meet the most stringent specifications in thousands of applications. A+ Felts have ideal characteristics for absorbing, wicking, filtering, sealing, cushioning, polishing, friction, shock absorption, thermal and sound insulation, padding, surfacing, vibration isolation, percussion control and decoration.

Send today for your personal copy of this practical guide to A+ Felts . . . the problem-solving engineering and design material.



American Felt Company is A+in SERVICE QUALITY DENGINEERING and RESEARCH



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DALL BEARINGS



To qualify for a Federal ball bearing, a steel ball has to be more than simply spherical to within 0.000025" and the right diameter to within 0.00005". It's got to be tough! A ¼"-diameter ball, for instance, must withstand a minimum of 4400 pounds of pressure. Whether it's going into a radial, angular contact, thrust, self-aligning or shafted bearing. Single or double row. Open or sealed. No wonder Federal numbers so many top industrial names among its satisfied customers. Our catalog describes hundreds of ball bearing types in all sizes. Send for it today. The Federal Bearings Co., Inc., Poughkeepsie, New York.

How to select or design a pump for pressure lubrication

by E. H. Schanzlin

Chief Engineer, Tuthill Pump Company

Our headline is something of a misnomer . . . for designing a pump for pressure lubrication today would be as pointless as designing a dowel pin.

Instead, there's a simple and increasingly popular answer to this problem. Practically every important manufacturer of air conditioning or large air compressors... manufacturers of machine tools... diesel engines... plus hundreds of manufacturers of diversified industrial equipment from valve operators to giant gear boxes... have selected Tuthill internal gear pumps for this demanding application because of compact size, economical price, quiet operation... and, above all, for their dependability, proven in over thirty years of operation.

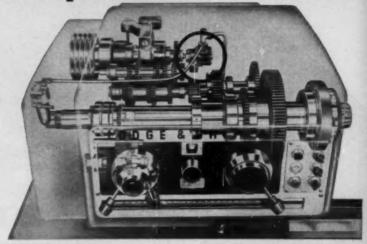
Internal Gear Operating Principles



Tuthill internal gear pumps have only two moving parts. The pumping principle is based on the use of a rotor, idler gear, and a crescent shaped partition cast integral with the cover.

Power applied to the rotor is transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the inside diameter of the rotor is sealed by the crescent.

As the pump starts, the teeth come out of mesh increasing the volume. This creates a vacuum, drawing the liquid into the pump through the suction port. The liquid fills the



Tuthill model ORL pump provides pressure lubrication for Lodge & Shipley POWERTURN lathes. Mounted in headstock area, this reversing pump is driven by a reversing clutch shaft, provides positive reversing action. Ports remain constant without use of values.

spaces between the teeth of the idler and the rotor, and is carried past the crescent partition to the pressure side of the pump. When the teeth mesh on the pressure side, the liquid is forced from the spaces and out through the discharge port.

Special Advantages of Reversing Pumps

Tuthill also offers a complete selection (375 models) of internal gear pumps with a special reversing feature. The unique construction of these units permits positive reversing action without the use of valves, and with the port positions remaining constant.

Reversing pumps are necessary when the lubrication pump must be driven by a reversing shaft, or when machinery must be shipped without knowing the ultimate direction of the driving unit.

A good example is shown above. A reversing pump is mounted directly on the reversing clutch shaft in the headstock area of Lodge & Shipley's POWERTURN lathes to provide dependable pressure lubri-

cation of these outstanding machine tools.

Stripped or Cartridge Models

For extremely crowded applications, or extra economy, Tuthill also offers a complete selection of stripped and cartridge models, in which only the basic pumping elements are supplied for incorporation directly into your equipment. These units have been widely used to supply positive pressure lubrication and hydraulic power in many important applications.

Over 800 Models

Tuthill's complete selection of internal gear pumps includes over 800 different models from stock for capacities from ½ to 200 gpm; for pressures to 500 psi; and speeds to 3600 rpm. Specially designed housings, shaft extensions, relief valves and many other features can be developed by Tuthill engineers for specific applications.

Write for complete catalogue No. 100 . . . or send us drawings on your application so Tuthill's engineers can make specific suggestions.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1/3 to 200 gpm; for pressures to 1600 psi; speeds to 3600 rpm.



TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois



WALDES TRUARC RETAINING RING

			- 1									
functio		for axial assembly					for taking up end-play					
nomenclature		To this document					axial assembly				radial assembly	
		basic		heavy duty	inverted		bowed		bevaled		bowed e-ring	prong-lock
		0	0	0	0	0	0	0	0	0	C	C
series no.		5000 N5000	5100	5160	5008	5108	N5001	5101	5002 N5002	5102	5131	5139
application		Internal fer Housings, Bores	External for Shafts	External for Shafts	Internal for Housings, Bores	External for Shafts	Internal for Housings, Beres	External for Shafts	Internal for Neusings, Bores	External for Shafts	External for Shafts	External for Shafts
size range	in.	.250 - 10.0	.125 — 10.0	.394 - 2.0	.750 - 4.0	.500 - 4.0	.250 — 1.500	.188-1.500	1.0 - 10.0	1.0 - 10.0	.110 -1.375	.09243
	mm.	6.4 - 254.0	3.2 - 254.0	10.0-50.8	19.0 101.6	12.7 -101.6	6.4 - 38.1	4.8 - 38.1	25.4 - 254.0	25.4 - 254.0	2.8 - 34.9	
function		for radial assembly					self-locking types					
nomenclature		crescent e	e-ring in		rlocking	e-ring	circular self-lock		king	grip-ring	self-locking	nut
		0	E		C	3	0	0	0	B		4
series no.		5103	513	3	5107	5144	5115	5105	5005	5555	5305	5300
application		External for Shafts	External for Shafts		ernal Shafts	External for Shafts	External for Shafts	External for Shafts	Internal for Housings, Bores	External for Shafts	External for Shafts	With Threads Screw
size range	in.	.125 - 2.0	.040 - 1	.375 .469	- 3.375	94562	.094 — 1.0	.094 - 1.0	.312 - 2.0	.079750	.062 — .438	
	mm.	3.2 - 50.8	1.0 - 3	11.5	9 - 85.7	2.4 - 14.3				2.0 - 19.0		1 E-H
	-										-	

Truarc retaining rings are precision-engineered fasteners which simplify design, speed production and reduce material, machining and assembly costs. They may be used to retain components on shafts and in bores and housings .040" to 10" dia. — and rings as large as 40" dia. have been developed for special applications! Truarc rings are installed in easy-to-cut grooves and self-locking types are available which do not require any preparatory machining. Altogether, there are 50 functionally different types . . . some with as many as 98 sizes . . . in 6 metals and 13 finishes.

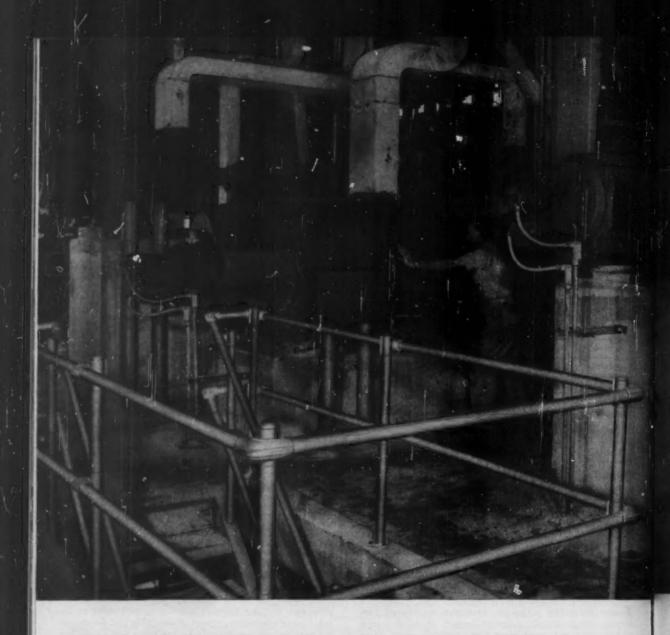
More than a fastener! Truarc rings function as mechanical components by replacing machined shoulders, set collars, rivets, threaded fasteners and other bulkier and more expensive fastening devices. They eliminate drilling, tapping, threading and other costly machining operations. Speed of assembly and disassembly further reduces manufacturing costs and simplifies field service.

Assembly tools for every requirement: Truarc offers you the most complete line of pliers, applicators, dispensers and portable magazine-fed tools for high-speed ring installation . . . even fully mechanized and automated equipment for mass-production assembly operations.

Engineering Service: We'll be happy to help you solve your fastening problems. Send us your blueprints or contact your local Truarc representative or distributor. They're listed in the Classified Telephone Directory under "Retaining Rings" or "Rings, Retaining."







CONTINUOUS PAPER 5 HOURS AFTER START-UP WITH RELIANCE DRIVE

The first sheet of newsprint was across the machine in 30 minutes. Four and one-half hours later the drier hoods were closed, and salable paper was produced shortly thereafter.

No electrical adjustments were needed during the start-up... no delays in production occurred. This is the result of Reliance's Coordinated Systems Engineering. On location were Reliance Sales, Service and Application Engineers... to make sure the

customer got what he asked for . . . and quickly. The Reliance VSMR sectional electric drive, installed at International Paper Company's Pine Bluff, Ark.

mill, is designed to operate the paper making machine at 2500 feet per minute, using 2908 installed horsepower.

Your Reliance Sales Engineer can help you solve your drive, motor or system problems. Consult your telephone Yellow Pages, or call or write direct.

RELIANCE...builders

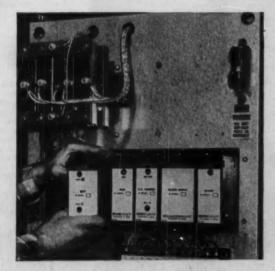
NEW DUTY MASTER D-5000 design brings you new standards in coolness, quietness... and more horsepower in less space. Frame dimensions that held 150 hp. now contain 300 hp. There is better heat dissipation from the frame itself. Air flows easily through the entire grilled end areas—exhausts through long, protected slots at the sides and bottom. New fingerless ducted rotor design means better cooling than any other previous motor. You get all the famous Duty Master features in this new D-5000 . . . special lubrication design, drip or splash-proof and complete open motor protection. Bulletin B-2515.





MASTER GEARMOTORS are built to meet the roughest type of service, as noted in this application on a self-unloading potato truck. This right angle gearmotor operates at low voltage . . . activates the chain drive of the unloader. Enclosed Master Gearmotors are impervious to water, dust, mud and other outside contaminants. They simplify installations, save space with vertical, horizontal or flange mountings . . . output shaft over, under, left or right. Full line, ½ to 125 hp. in right angle, parallel or combination. Bulletin E-2409.





REEVES MOTODRIVE operates this automatic gathering machine, which collates magazine sections. Due to the varying number of books per hour... 1000 to 8000... use of the Reeves Motodrive is both practical and economical. Speed settings within its output range are infinite. You can get a Motodrive from ¾ to 40 hp. Speeds as high as 4660 rpm. and as low as 1.71. Speed variation from 2:1 to 10:1. Hundreds of space-saving assemblies. Catalog G-100.

NEW SCR REGULATORS AND EXCITERS. Reliance is the first to offer, for industrial use, a complete line of regulators and exciters using solid state silicon controlled rectifiers. "Cardpak" plug-in type modules give you low maintenance—greater dependability. Now, Reliance V*S Drives are more reliable than ever, because these devices are extremely long-lasting, tubeless—and positive in performance.

RELIANCE ELECTRIC AND ..

DEPT. 28-10, CLEVELAND 17, OHIO . Canadian Division: Toronto, Ont.

Circle 304 on Page 19

POAL proves it...

breaking point tests show Allen screws are consistently better



PQA is the symbol of unquestioned quality at Allen. It stands for constant quality control from rigid upgrading of incoming raw materials to final, unconditionally guaranteed shipment to you.

To give you some idea: Federal Spec. FF-S-86a calls for 4,950 lbs. for the ½-20 cap screw. Day-in, day-out breaking point tests of these screws prove that Allens are *consistently* better...well above the minimum requirement!

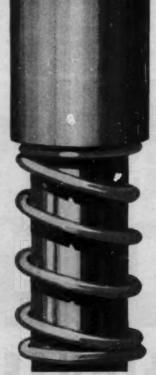
Quality checks like this one confirm PQA every step of the way through Allen's manufacturing process. And to help you keep costs down and profit margins up, Allen manufactures 1457 standard sizes.

Remember...it costs you no more to have genuine Allens right from stock, and they are only a minor fraction of your assembly costs.

ALLEN

MANUFACTURING COMPANY HARTFORD 1, CONNECTICUT, U.S.A.

Plant at Bloomfield, Connecticut . Warehouses in Chicago, Cleveland and Los Angeles





Genuine ALLEN products are available only through your ALLEN Distributor. He maintains complete stocks close by to help cut your freight costs, inventory, warehousing and handling. He offers fast, single-source service. He knows Allen products. And he makes Allen Engineering Service available to you any time. Call him!



WEAR RESISTANT THOMSON

60

e

and difficulty of fabricating long, hard & straight parts by conventional methods!

hardened and ground

SHAFTS, ROLLS, GUIDE RODS and other long-round parts
ELIMINATE WEAR and REDUCE COST

of over 15 years of experimental work and production experience with hardened and ground shafts which are a requirement for BALL BUSHINGS, the Linear Ball Bearing manufactured by Thomson Industries, Inc.

The special techniques and equipment that have been developed enable high production rates and low handling costs. This permits big savings over conventional methods which are plagued with erratic warpage, straightening and resultant grinding problems. Finished 60 Case parts frequently cost less than the scrap losses that result from conventional methods.

60 Case material has a surface hardness close to 60 on the Rockwell C scale which is essential to resist wear.

Long lengths of material ranging in diameter from ¼"
to 4" are stocked to enable prompt shipment of 60 Case
parts, with or without special machining. Write for
literature and name of your local representative.

For emergency needs call collect MAnhasset 7-1800

ADVANTAGES of 60 Case

- . COST REDUCTION
- GROUND FINISH
- · HARD BEARING SURFACE
- . STRAIGHT PARTS
- . NICK-& DENT-PROOF
- DELIVERY FROM STOCK
 ADDED STRENGTH
- ACCURATE DIAMETERS
 ADDED S
 UNIFORM HIGH QUALITY

TYPICAL 60 Case PARTS

GUIDE RODS • SHAFTING • ROLLS • TRAVERSE RAILS
PISTON RODS • ARBORS • LEADER PINS • TIE RODS
KING PINS • AXLES • CONTROL RODS • GUIDE POSTS
MANDRELS • BEARING ROLLERS • SPINDLES

THOMSON INDUSTRIES

Inc.

Dept. C-5, Manhasset, New York

Circle 306 on Page 19

PARTS HARDENED to 60 C

increase life reduce cost!

How adapters affect "V" packing performance

The widespread popularity of "V" type packings is largely due to their versatility. For low pressure applications, a single "V"—with male and female adapter—may be sufficient. A set, incorporating many "V's", can withstand pressures well over 50,000 psi. They are used in cylinders (inside packed) and on rods (outside packed).

The overall performance, both sealing efficiency and service life, however, is largely dependent on the adapters which support the packings—and primarily on the female adapter because it supports the entire set. Excessive friction, packing extrusion, short service life and failure to properly seal can all result from adapters that are oversize, undersize, or made from materials not suited to the application.

Common Adapter Materials

Adapters are usually made of metal, phenolics, hard homogeneous rubber, fabricated rubber or leather. Each material has its merits and its limitations. In this group there is a range from hard, non-compressible materials to those that are softer and compressible.

What The Female Adapter Must Do

As we said earlier, the female adapter supports the entire set. But that's only part of its job. It must be hard enough to prevent extrusion of the "V" under pressure. Yet it must be soft enough to compress without fracturing. It must "breathe"—compress and flow radially under pressure then recoil when pressure is reduced thereby bridging the metal clearance.

Since "V" packings are in the

category of "lip" type packings, their sealing action is due to the force of the actuating pressure expanding the packing. As a result of this "breathing" action, friction on the return stroke is negligible.

Adapter Material Selection

Now to get back to adapter materials. Metal, usually brass or bronze, is hard and inflexible. It can be machined so that the clearance is held to a minimum but it cannot breathe with the packings. Excessive friction and wear usually result.

Phenolic adapters are only slightly better. They "breathe" very little and at high pressures often fracture.

Hard homogeneous rubber, fabricated rubber or leather adapters are superior to both metal and phenolics. This is because these materials are compressible—they will "breathe" with the packing thus bridging the clearance and eliminating extrusion without unnecessary friction.

Homogeneous rubber adapters should be of about 55 Durometer on the "D" scale, fabricated rubber should be a fairly hard texture, and leather adapters are usually impregnated with a hard wax.

Houghton, the only manufacturer of both packings and fluids for hydraulics, has widespread experience in packing design, application and performance. For unbiased recommendations and help in improving packing performance, write E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.



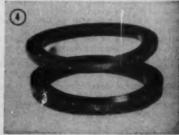
METAL ADAPTER



PHENOLIC ADAPTER



HOMOGENEOUS RUBBER ADAPTER



FABRIC ADAPTER

Houghton

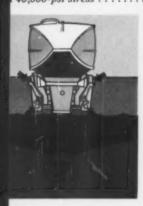
MOUSTRY'S PARTNER IN PRODUCTION



When a 1/2" aluminum bolt bears more than a 40,000-psi stress...

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that's Alcoa Total Ability at work!



Hang a 210-lb outboard on the transom of a frisky speedboat, uncork its 75 horses worth of power and go zigzagging across a choppy sea. Given these circumstances, outboard designers tell us, tension on the engine mount bolts exceeds 40,000 psi.

As insurance that these bolts will never snap, Alcoa furnishes ½-in. x 4-in. hex-head aluminum cap screws that have a minimum tensile strength of 62,000 psi. That's enough reserve strength to stand up under unexpected impact or years of fatiguing use.

In screw machine parts as well as forgings, castings, extrusions and impacts, Alcoa can deliver aluminum in an almost limitless variety of

forms, colors, textures, tempers and thicknesses.

Alcoa also produces tough, cold-headed parts like these for vibration-absorbing aircrafttype engine mounts.

Alcoa Total Ability, unmatched by any other lightmetals manufacturer, can help you achieve an ingenious de-

sign solution, less waste in production or a product that sells better. How can we help you? Cayour nearest Alcoa sales office, or write Alum num Company of America, 856-K Alcoa Building, Pittsburgh 19, Pa.



ALCOA ALUMINUM
SCREW MACHINE PRODUCTS



DESIGN

October 12, 1961

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Growing Up Gracefully

SEVERAL weeks ago this page observed that one mark of a professional is the salary paid for services rendered. Improvement in engineering salaries, relative to personal incomes of other groups and the true value of the dollar, is concrete evidence of professional recognition.

Another mark of the maturing of engineering is the growth of support groups—analogous to the medical profession with its increasing dependence upon specialists. In engineering, one type of support is well established: Technical specialists who can bring a competence and depth of knowledge to the design effort that few practicing engineers could ever develop while coping with everyday, first-order problems. Experts in stress analysis, kinematics, electronics, mathematics, etc., truly support the design effort.

Other specialty groups have been conceived and developed to support design on more pragmatic fronts. They appear in growing number: Standards, reliability, pro-

ducibility, value analysis, product assurance, etc.—and tomorrow will bring more new labels. One could lament this trend, pointing out that design is releasing its prerogatives to other "improvement" groups. But it seems self-evident that these groups will become essential and entrenched to the degree that they add value to the total design investment. Overleaf, Phil Tripoli discusses one such design-support function—value engineering.

One may gain the impression that the design engineer is in danger of being displaced or becoming a mere pawn. Not so! If anything he's more in the limelight—and on the spot, too—than ever before. He dare not fail to respond to the demands and rewards before him—or to take advantage of the assistance offered him.

Ben Hummel

EXECUTIVE EDITOR

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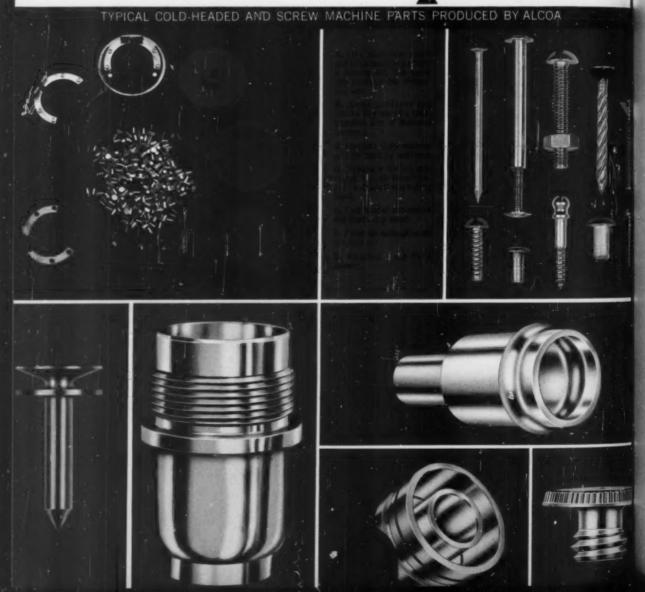
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Ben Humme

EXECUTIVE EDITOR



Value

Smedley, you just don't fit into our Value Engineering program.

PHILIP TRIPOLI

Senior Engineer, Value Engineering Branch Norair Div., Northrop Corp. Hawthorne, Calif. ADDISM is usually associated with the propensity of the female for exotic hats, the strange taste of the younger generation for the tuneless beat of rock-and-roll music, the stunts of college boys, or the defeatist abstractions of the beatnicks. The mature male, while resigning himself to some of these absurdities, and even secretly approving of some female fancies, nevertheless views the faddist with a certain amount of derision. Yet, even industry is subject to fads. Value engineering fits this category.

The functions of value engineering are not new, although the name is. Actually, production design, product analysis, design producibility, and cost engineering have been performing much the same function. But a new glamor has been attached to the concept.

The title—Value Engineering—fits the function very well; however, care should be taken that the excessive zeal for, and the potential exploitation of, this field does not cause value engineering to go the way of the efficiency expert. This article indicates what can be expected from a value-engineering program, and the orientation and climate that should be developed in order to insure success of the program.

What the Program Can Do

Value engineering offers the designer a powerful tool for use in decision making. A well-developed

engineering

Reactions to value engineering have ranged from eager acceptance to militant rejection. But the true worth of a VE program seems to lie somewhere between the two extremes. What can reasonably be expected from such a program? And how should the program be set up for best results? Here's how one value engineer sums it up.

program makes available information which would require a great expenditure of time and effort if left up to the individual. In many cases the result is design optimization at minimum cost.

Contributions to Engineering: A value-engineering group, composed of specialists in the major fields (machining, sheet-metal fabrication, welding, etc.) can explain in minutes what would take the individual designer hours of investigation. In addition, these specialists can always punctuate their remarks with a dollar sign, which is the basic parameter for relating the value of a design.

The competent value engineer is not prejudiced for or against any manufacturing process. He compares a given process against other possible methods of manufacture, and furnishes costs and related data to substantiate his recommendations. While manufacturing is likely to press for designs which utilize company facilities and equipment, the value engineer considers all known practical processes.

Value engineering acts as a depository of infor-

mation which is readily transferable. This function, which is often overlooked, can significantly benefit the company by preventing duplication of effort in the design of detail parts.

Value engineering can play a significant role in large and small production runs. When extended production is involved, in time the design can be improved by suggestions from manufacturing, tooling, purchasing, and/or by a directed cost-reduction program. However, this is an expensive procedure, which could have been eliminated by optimizing the original design. Obviously, when production quantities are small, the design must be optimum from the outset. An effective value-engineering program can insure minimum cost regardless of the number of items to be produced.

Cost Reduction: In literature extolling the virtues of value engineering, examples are given of fabulous savings attributed to this program. If the initial designs were poor in the first place, substantial cost reductions could be realized by value



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. . . sizable savings even in a well-balanced engineering department . .



. . . reluctance of the designer to utilize the value engineer's services . .

engineering. But ordinarily, such is not the case.

A value-engineering program may show sizable savings even in a well-balanced engineering department. But generally, individual savings are less than \$500; however, the frequency of their occurrence can add to a satisfying sum.

Even more important results of a value-engineering program are the potential savings than can accrue from acquired learning, which can be used in future designs.

Implementing the Program

An effective value engineering program must possess the following characteristics:

- 1. Complete approval and backing of management.
- Trained, qualified, and competent personnel to evaluate designs and/or products.
- Feedback system for checking the effectiveness of the program.
 - 4. Cost-data system, to serve in evaluating designs.
- Close co-ordination with and support of purchasing, manufacturing, tooling, quality control, planning, etc.
 - 6. Educational program.
 - 7. Development-research program.

Management Backing: Management can stimulate the desired response to a value-engineering program in several ways:

- Demonstrably endorse value engineering by impressing on supervisors that their full co-operation and participation in the program are expected.
- 2. Make it known that drawing-change requests will be scrutinized to determine the value quality of the original designs. This approach provides management with a double-edged check on the effectiveness of the value-engineering program, since any poor product features could be attributed to one of several factors: Value engineering has not demonstrated competence; value engineering was not sufficiently utilized; departments other than design and value engineering were deficient.
- 3. Establish cost targets for all projects. Since many projects operate on limited budgets, the services of the value-engineering group should be sought at the early stages of the designs. Besides helping to optimize the designs, value engineering can provide estimates of expected product costs. These evaluations can be used not only to compare predicted costs against target costs, for a given percentage of completion, but also to check manufacturing charges for those items.

One of the difficulties encountered in a value-

Value Engineering vs Value Analysis

Some companies maintain both value-engineering and value-analysis programs. There is no conflict between these programs if the responsibilities of each are limited by their natural functions.

Any change made in the product must be preceded by a design change. Since the primary function of value engineering is to assist the designer in optimizing the design, it is natural to expect that any proposed design change be first checked by value engineering.

This provides an obvious boundary for the two programs. Value engineering is responsible for design evaluation, including review of proposed changes to the design. All other efforts to improve the product or to reduce costs are the responsibility of value analysis.

The following actual cases show the distinction between the functions of value analysis and value engineering:

- A nylon phenolic honeycomb required for the core of a vertical stabilizer tip was purchased in a 2 x 13 x 43 block at \$59.30 per block. In this form, material waste was high. Purchasing found that honeycomb could be brought for \$30.50 in three panel thicknesses closer to actual requirements. No design effort or decision was required. This is good value analysis.
- A drawing-change request, initiated by manufacturing, suggested that the core in this same vertical stabilizer tip be changed from a combination honeycomb and foamed-inplace core to a fully foamed-in-place core. Adoption of the proposal would require a drawing change; therefore, value engineering conducted the evaluation. The change resulted in substantial savings.

engineering program is the reluctance of the designer to utilize the value engineer's services. Understandably, the designer may resent the implied suggestion that his design can be improved. There must be a genuine attempt in a value-engineering program to convince the designer that he and the value engineer are a natural team. But selection of the final design should rest with the designer.

In some companies, even though the designer has received formal training in stress analysis and even though he performs initial stress calculations, the stress analysts are responsible for the structural efficiency of the product. Yet, in the area of costs, where the designer's training and experience are very limited, no positive control is provided.

Some proponents of value engineering believe that an effective control can be provided by requiring

The Value Engineer

The key to an effective value-engineering program lies in the proper choice of personnel. The following points will help to determine suitability for the job.

- Education. An engineering degree, or its equivalent, is of prime importance.
- Experience and Background. Several years' design experience is desirable. The value engineer must have a broad practical knowledge of various manufacturing processes, and their relation to cost. He should also be familiar with the practices of the various functions not directly related to engineering.
- Personality and Temperament. Since the value engineer must deal with many individuals, he should like people; in addition, he should not be too sensitive if his suggestions are rejected. And, finally, he should be patient.
- Ability to Cormunicate. Many value-engineering studies culminate in reports. For this reason, a value engineer should be able to write clearly. The ability to sketch also comes in handy.



. . the value engineer should have a well-rounded background . . .

value-engineering approval of all drawings. This is a drastic action, which may not accomplish the desired results, especially in the event of crash projects. Instead, the services of the value-engineering group should be sought voluntarily by the designers. However, unless management generates a climate which will induce this attitude, full participation in a value-engineering program will be slow in coming.

Trained Personnel: The key to an effective valueengineering program lies in competent, well-trained personnel.

The value engineer should have a well-rounded background, with broad training in engineering, costs, processes, and communication. Since the very nature of his function almost insures that his road will not always be smooth, he should have the ability to get along with people. For these reasons, liaison engineering provides an excellent background for value engineering.

Value engineering is, at best, a thankless job. Rarely, can the value engineer take credit for a successful idea because, generally, its adoption was the culmination of team effort. For this reason, a value engineer must like the work for itself.

Feedback: Since the value of a design is related to its true cost, the ideal feedback system should include a cost-accounting procedure. However, the value of a design may also be appraised by the following methods:

- Establish cost targets for each project. Then, if the product cost, at any percentage-completion check, significantly exceeds the cost target, an investigation will reveal the reason and indicate corrective action if advisable.
- 2. Review the drawing-change requests. A statistical sampling of drawing-change requests, as well as engineering orders, can be very informative. But it should be remembered that an apparent deficiency in the design may be attributed to established parameters not controlled by the designer. For this reason, a review of drawing-change requests should be accompanied by discretion.
- 3. Compare product cost against industry averages for equivalent products. This type of check is superficial. It could even be argued that the comparison has no basis in fact. However, it is indicative of how product costs compare with those of competitors.

The approach outlined in these steps will be more realistic and definitive in gaging the effectiveners of a value-engineering program than the periodic recording-reporting system usually adopted. The latter creates the drudgery of bookkeeping and encourages distortion of facts. Many problems presented to value engineering take as long to record as to resolve. Thus, their solution would be of little use to management in judging the value of the program.

Cost-Data System: Since cost information is of vital importance in evaluating designs, it is imperative that certain data be established for company-wide use:

1. Time standards for all company operations and processes. The definition of "standard time" should be learned



. . . value engineering is continually using the services of purchasing, tooling, and manufacturing . . .

and understood by all supervisors, so that everyone operates on the same basis.

Rates for various types of labor. A central agency should establish the hourly cost of various types of labor (machining, welding, etc.) performed by the company.

3. Learning curves. Most people confuse learning curves with realization curves. Learning curves show the effect of operator experience, which, in turn is influenced by the size of release quantities. On the other hand, a realization curve shows the composite effect of the size of the production-release quantities, operator learning, methods improvement, engineering changes, and evolutionary forces (for example, a new process is developed, equipment is automated, etc.).

This realization curve is predictable for a large project because it deals with the average effect on a multitude of parts and components. But for value-engineering work, the same realization curve is generally not applicable for the following reasons: Specific designs are under consideration, and no engineering changes are anticipated for them; methods for producing the item have been analyzed and are fairly well defined; evolutionary improvements that may occur are nebulous.

4. Material Costs. Value engineering should be furnished with pricing lists of most commonly used materials. This will reduce the calls made to purchasing for this information, and also permit a continuous check on pricing changes.

Co-operation and Co-ordination: Since value engineering is continually using the services of purchasing, tooling, and manufacturing, it is desirable to assign representatives of those departments to co-ordinate value-engineering requests. By the same token, these departments can request the help of value engineering in evaluating suggestions not normally handled by liaison engineering.

Educational Program: A current trend is to try to make the designer cost-conscious by forcing him to participate in seminars, committees, and other activities which feature beautifully prepared pamphlets full of high-sounding slogans. This approach may appeal to the novice, but it is not palatable to the experienced designer.

Another plan attempts to indoctrinate the designer in the use of costs in the preliminary analysis of his designs. Besides being expensive, the meager smattering of cost knowledge thus attained often misleads the designer. There have been cases where designers who had a first success with a particular process tended to use this process in subsequent designs even though other methods would

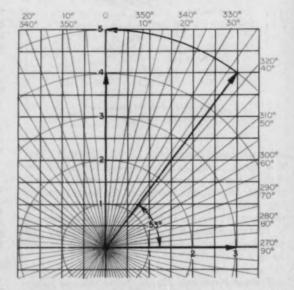
have been more economical.

The designer requires only a brief discussion of the elements of costs. In an educational program, the main emphasis should be in periodically presenting movies, talks, and literature, describing the latest manufacturing processes, materials, equipment etc. which can help the designer to solve his problems. A judicious sprinkling of cost information can be used to season the presentation.

Tips and Techniques

Finding Resultants

A sheet of light-weight rectangular co-ordinate paper, overlaid on a sheet of polar co-ordinate paper, as shown, provides a handy method for finding the resultant of two vectors, and the angle between the resultant and the x axis.



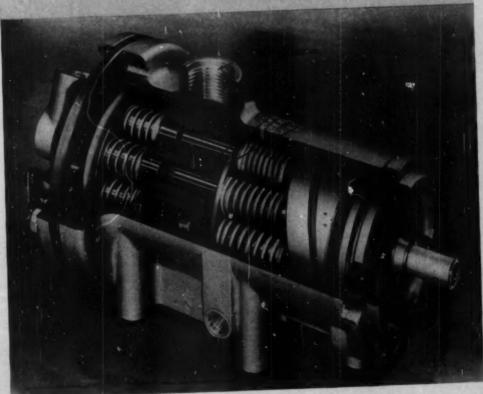
In the illustration, the x component = 3, the y component = 4 and the resultant, from the chart, is 5. The angle can be read from the polar-coordinate paper, and is about 53 deg.—Sidney Krav-riz, Dover, N. J.

Hydraulic Pumps and Motors

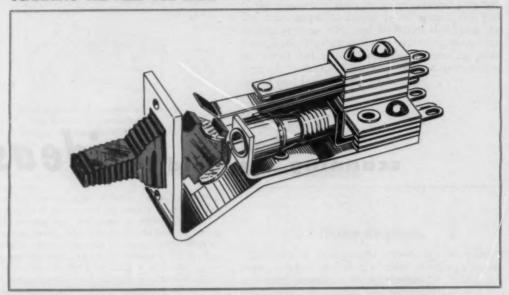
In the August 17, 1961, issue, Page 139, the sign of C_I in the right-hand side of Equation 2 should also be reversed to describe fluid-motor performance.

scanning the field for ideas

inlet controls output of an axial-piston pump. The cylinder block, which contains the inlet port, can be moved axially to position the inlet port along the stroke of the pistons. Thus the effective stroke length of the cylinder is varied, but the mechanical stroke length remains constant. Principle employed in a pump by Weatherhead Co., Cleveland, Ohio.

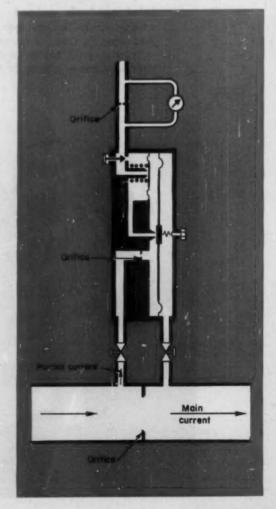


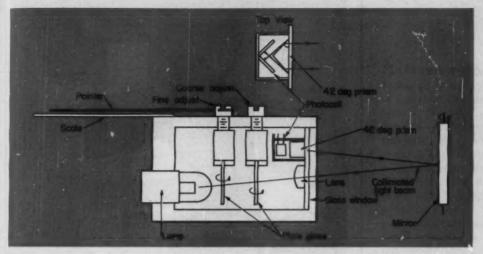
SCANNING THE FIELD FOR IDEAS



Toggle moves filters to control color coding of a lever switch. Thus, one lamp provides multiple colors to indicate position of switch. Principle employed in a switch by Switchcraft Inc., Chicago, Ill.

Regulators smooth pulses to permit flow measurement of a pulsating stream. A portion of the flow from the main stream is passed through tandem pressure regulators to produce a uniform flow. Pressure drop of this uniform flow through a fixed orifice provides a measure of the flow. Principle employed in a flow meter by Conti Elektro AG, Berlin, Germany.





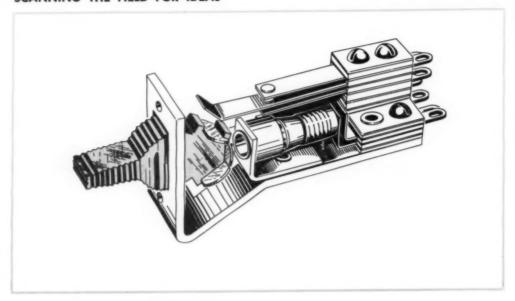
Prism detects movement of a light beam to provide a high-sensitivity angle sensor. At zero reading, the light reflected from the mirror is internally reflected in the prism. However, when the mirror is rotated slight-

ly, more light is refracted through one or the other side of the prism. The resulting light unbalance is measured by photocells. Principle employed in an angle sensor by HH Controls Co., Burlington, Mass.

Cloth forms element for an electric space heater. A strip of graphite cloth, wound on a frame, forms the resistor element. The blower fan draws air in through the case and on through the graphite cloth. Graphite cloth for heating element developed by National Carbon Co., Union Carbide Corp., New York, N. Y.

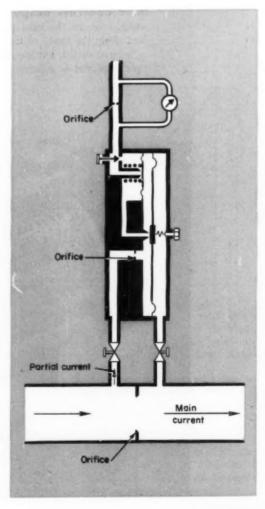


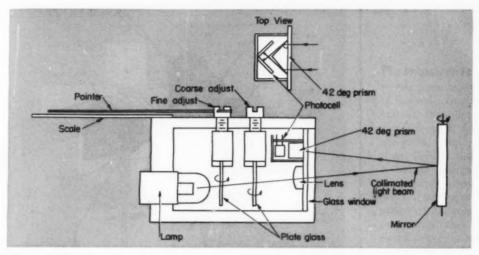
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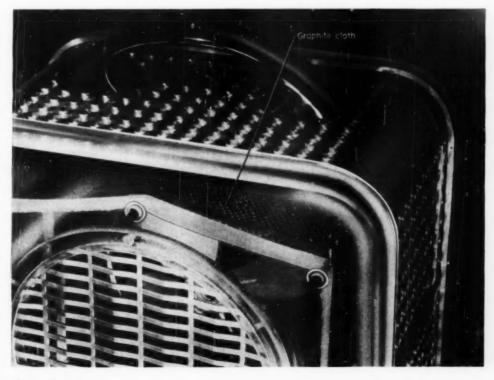




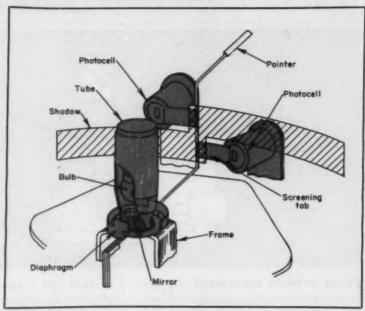
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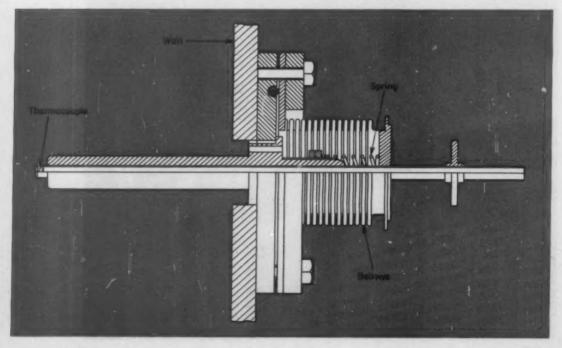


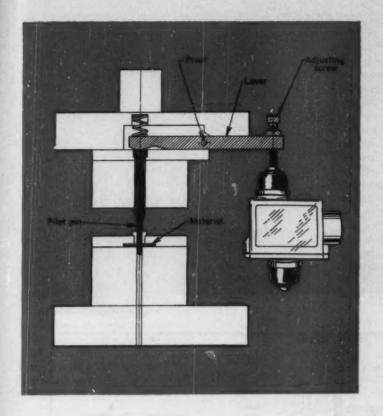
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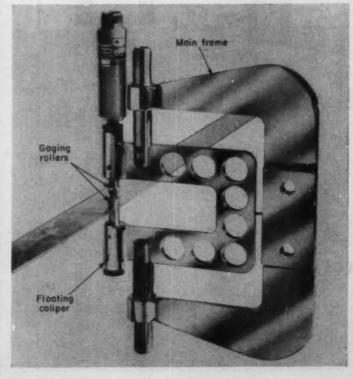
Pointer shades photocells to actuate a meter relay. Movement of the pointer shades one or the other photocell from a beam of light to actuate a relay. Screening tab length determines operating band width of the meter. Principle employed in a meter relay by P. Gossen & Co. GmbH, Erlangen, Germany.

Vacuum positions probe in a through-the-wall thermocouple. The probe is mounted in a flexible metal bellows which collapses when a vacuum is applied within the container. An adjustable spring, operating against the bellows, controls the force of the probe against the object being measured. Principle employed in an automatic thermocouple by the United Kingdom Atomic Energy Authority, Risley, England.



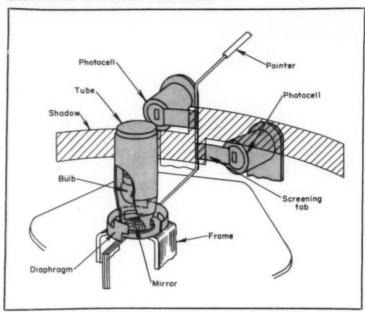


Pin trips switch to stop punch press motor in case of misfeed. In normal operation, the pilot pin enters the pilot hole when the press closes. However, if the hole in the material is not in alignment with the pilot pin when the press closes, the spring-loaded pilot pin is forced upward to actuate the normally closed switch. Die protection device developed by Micro Switch Div., Min-neapolis-Honeywell Regulator Co., Freeport, Ill.



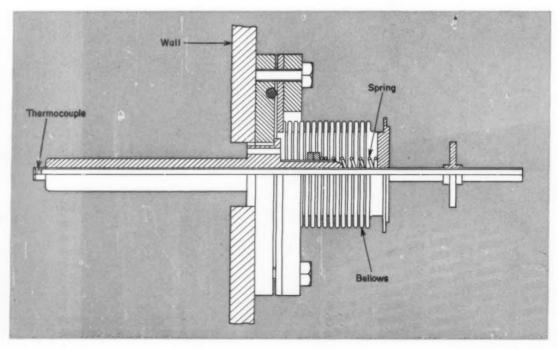
Floating caliper supports gaging rollers. Vertical travel of the upper roller in relation to the caliper permits the roller to follow nominal thickness variations. The entire caliper and roller assembly can move vertically within the C-shaped main frame to follow any vertical motion of strip being measured. Principle employed in thickness gage by Daytronic Corp., Dayton, Ohio.

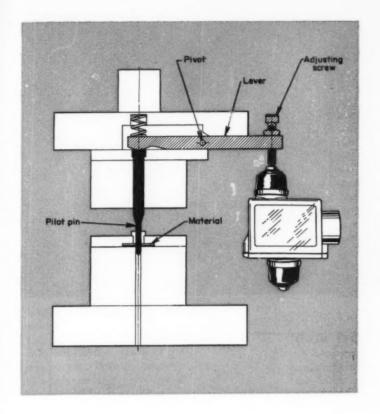
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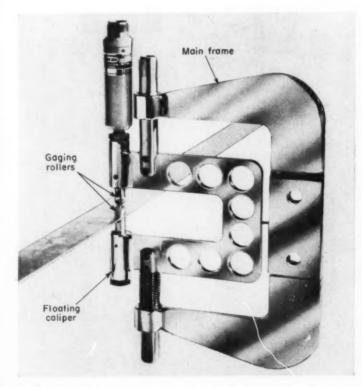
Pointer shades photocells to actuate a meter relay. Movement of the pointer shades one or the other photocell from a beam of light to actuate a relay. Screening tab length determines operating band width of the meter. Principle employed in a meter relay by P. Gossen & Co. GmbH, Erlangen, Germany.

Vacuum positions probe in a through-the-wall thermocouple. The probe is mounted in a flexible metal bellows which collapses when a vacuum is applied within the container. An adjustable spring, operating against the bellows, controls the force of the probe against the object being measured. Principle employed in an automatic thermocouple by the United Kingdom Atomic Energy Authority, Risley, England.





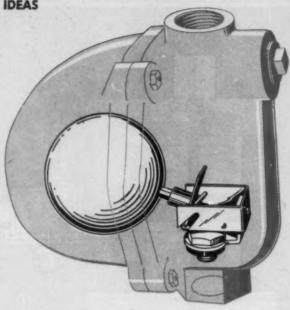
Pin trips switch to stop punch press motor in case of misfeed. In normal operation, the pilot pin enters the pilot hole when the press closes. However, if the hole in the material is not in alignment with the pilot pin when the press · closes, the spring-loaded pilot pin is forced upward to actuate the normally closed switch. Die protection device developed by Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

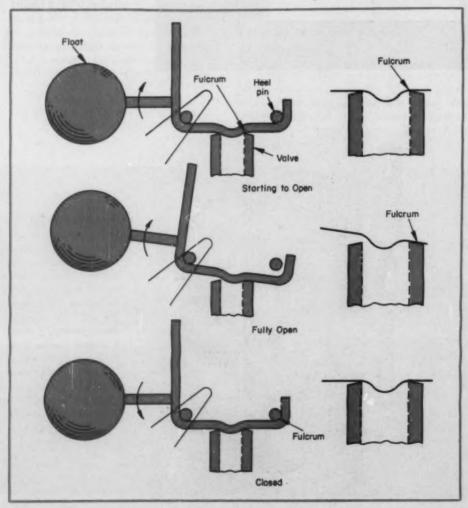


Floating caliper s u pports gaging rollers. Vertical travel of the upper
roller in relation to the
caliper permits the roller
to follow nominal thickness
variations. The entire caliper and roller assembly can
move vertically within the
C-shaped main frame to
follow any vertical motion
of strip being measured.
Principle employed in
thickness gage by Daytronic
Corp., Dayton, Ohio.

SCANNING THE FIELD FOR IDEAS

Convex valve seat shifts operating fulcrum of valve during the valve stroke. When the float-actuated valve starts to open, the fulcrum is near the valve, providing maximum mechanical advantage to open the valve against pressure. As the valve is opened farther, the fulcrum moves outward along the valve seat, reducing the mechanical advantage, but increasing valve travel in proportion to float rise. When the liquid level drops, the valve arm pivots about heel pin to force the valve onto the valve seat. Moving-fulcrum principle employed in steam trap by Farris Engineering Corp., Palisades Park, N. J.

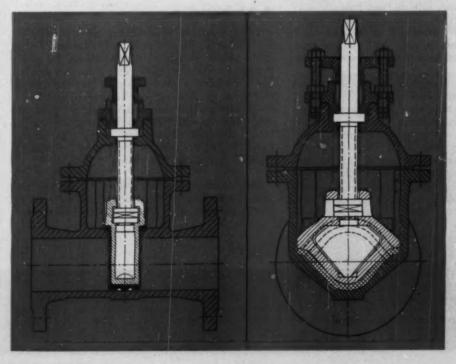






Curved-end links provide a continuous surface belt conveyor. The interlocked and overlapped links can traverse convex or concave curves. Principle employed in a belt conveyor by May-Fran Mfg. Co., Cleveland, Ohio.

Gate seals fluid in a shutoff gate valve. Since the gate seals against the smooth bore of the valve, no ridges or grooves are required. Thus the valve produces minimum pressure drop in the open position. Principle employed in a valve by Johannes Erhard, Heidenheim/Brenz, Germany.



JOHN V. E. HANSEN

Contract Manager National Research Corp. Cambridge, Mass.

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- Progress Reports
- Technical and Financial Problems
- Delivery Schedules
- Security
- Presentations

AINTAINING a good level of government contract business is by no means simple. The effort required depends upon the product, the organization selling it, the amount of competition, and the technical, political, and financial situation. Coping with these variables to obtain a government contract—particularly a research and development contract—is only half the struggle. The next step—performance of the contract—is every bit as demanding.

If this is the first research and development contract that your organization has had, the first few weeks and months may seem fairly hectic. Many regulations affect the manner in which contracts must be performed under the government's rules, and learning to live with these rules is never easy. However, beyond the written rules (contractual requirements) there are some unwritten rules or guide lines that govern your performance. It seems justifiable to categorize these as "requirements," because awareness of them may make quite a difference in

the efficiency with which you perform your present contract, and in your success in acquiring additional contracts.

Administration

These unwritten requirements are the basis for establishing sound contractual relationships. Let us define sound contractual relationship as the establishing of a working rapport with a contract monitor and his agency in such a manner that the association serves to enhance your reputation, and leaves the impression that your organization is a good one to do business with. This means going beyond the legal contractual requirements. Many organizations have fulfilled contracts without ever establishing a sound contractual relationship.

Supplementary Progress Reports: There are two basic advantages to establishing and maintaining a close working relationship with the project mon-

... Unwritten rules govern contract performance. Awareness of them may make the difference between good or bad contract relations

. Many organizations have fulfilled contracts without ever establishing a sound contractual relationship . . .

R&D CONTRACT!

itor. First, it improves contract performance, and second, it will likely prove to be a source of additional work.

As a typical example of the means by which such a close working relationship can affect your performance in a contract, consider the matter of progress reports. Certainly, as required by the contract, you furnish periodic progress reports. Through these, the contract monitor gets a fairly good idea of what is going on. Unfortunately, with the normal delays in processing reports, forwarding them to the agency, and having them distributed through normal channels, any progress report is at best a good indication of what happened 45 days ago, and not what happened in the last week or so. Obviously, then, a close contact with the contracting agency serves to complement progress reports and keeps the project monitor informed of the latest developments. Thus any comments made by the monitor, either in terms of assistance or possible redirection of the work, can be received much

earlier than if the contract monitor had to rely on the progress reports alone.

Technical Guidance: There is also the question of guidance on the evaluation of results. For example, assume that you are developing a new material. You undertake certain tests to evaluate ma-



The contract is between you and "the government." Here, the author, starding at right is participating in a conference with the contract monitor.

. Far from resenting it, contract monitors appreciate requests for help when technical problems arise . . .

... "Cross pollination"—the exchange of technical information—helps both the contractor and government contract agency to solve current problems . . .

... Missing a delivery date by a day or two can be critical if the program is closely integrated with other programs, as is frequently the case ...

terials developed in the course of the program. It would be worthwhile to discuss these tests with the project monitor while the operations are underway, because the contract monitor may very well be able to assist by providing recent unpublished information that would affect your work.

The technical man monitoring your project has probably had a lot of experience in this specific area, unless it is a very unusual situation. He is generally responsible for a number of other contracts at the same time, all in the same technical area, and he therefore represents a good store of knowledge. Allow him an opportunity to make technical contributions in any problem areas when it seems reasonable.

Again, you may be up against a specific technical problem, and request assistance from the monitor. Far from resenting requests for help, most monitors are apt to appreciate a company's attitude in such cases. Consider the alternative: Faced with a specific problem that is holding up your work, you quietly go on your way looking for an answer, misleading the contract monitor into thinking that all is well. When the truth finally becomes known (and it always seems to come out at the worst time), you have lost considerable ground—and have done quite a bit toward ruining your contractual relationship.

Exchange of Information: In doing your work and in contact with other agencies, you begin to represent a source of information as to what is going on elsewhere in the field, and in the other agencies you deal with. In this respect you can be of assistance to your project monitor by filling him in on developments in other areas.

Much "cross pollination" is achieved by government contractors who pick up pieces of information and pass them along. On more than one occasion, contractors have found that information they relayed to a contract monitor helped him with some of his current problems.

The foregoing is particularly true today, when many organizations are designing components for space vehicles. The lack of knowledge of how materials behave in space, added to such problems as heat transfer and lubrication (which impose new requirements in space applications) combine to make apparently simple design tasks rather substantial problems. Any information passed along in these design areas will almost surely be of value to the monitor in his work.

Technical and Financial Problems: In maintain-

ing contractual relationships it is also important to alert the monitor to possible problems, both technical and financial. The importance of raising these "storm warnings" (particularly in the financial area) cannot be stressed too much. The reason is simple: In the matter of money, in particular, the government usually acts with what might be considered extreme slowness by industrial standards. The commitment of funds in most routine programs results from many months of negotiation through various government channels. Therefore, if you think the program is going to require additional funds and you intend to make a request for such funds, do so at the earliest possible moment. To encourage such promptness, many contracts require fund reports as well as technical progress reports. The idea here is to give the government as much advance notice as possible of any potential overruns on government contracts.

Although this notice is helpful, the procedure is still subject to the normal delays. Therefore, on occasion, by the time the fund reports (indicating that you are spending at an excessive rate) are received, the damage is done and it may be too late to get additional funds. Here again the responsibility is yours. If you see problems coming (either financial or technical) call it to the monitor's attention as early as possible. It is certainly better to be criticized for crying "wolf" when a problem doesn't materialize than to wait until it is so late that it becomes impossible to do anything about it.

Delivery Schedules: In this discussion it is assumed that you would adhere rigidly to the contract delivery schedules, both in terms of reports and materials. These requirements are legally established by the contract and you are leaving yourself in a highly vulnerable position whenever you ignore them. It is particularly unwise to assume that minor delays in deliveries or reports will not be noticed. Even missing a delivery date by a day or two can be critical if the program is closely integrated with other programs, as is frequently the case. Therefore, if it appears that you are about to miss a scheduled delivery date, contact the agency in question and alert them to this in order that they may take this into consideration in their plans and schedules,

Again, consider the space component designer. Many of our current programs are predicated upon space "shots" that must adhere to rigid schedules. In the extreme case—certain shots destined for interplanetary targets—these can be made only dur-

... A contract monitor will judge your company primarily through your representatives

ing opportune periods dictated by nature. Failure to meet a schedule for such shots means many months must elapse before conditions permit scheduling another shot. Moreover, keep in mind that every contractor—regardless of how small a part his design or development work contributes—is a vital part of the team. The earlier a potential trouble spot in a contractor's schedule comes to light, the better for all concerned.

Security: On government contracts security is important. If a company is going to do classified work, it must set up an efficient security system. In day-to-day activities with the government agency, you should create confidence that your firm is security conscious. Any time classified documents are sent through the mails in a manner that is inconsistent with security regulations, or there is other evidence on the part of the company that it has a casual attitude toward security, be assured that it will not be overlooked by the government agency. Not only will you be on the receiving end of a security infraction notice, but you also tarnish your reputation somewhat.

Communication

So far we have covered the need for maintaining a good contractual relationship, that is, the "why." Now let us look at the "how."

Personal Communications: To start with there is the personal element. From purely legal and contractual standpoints you are doing business with "the government." However, the government has designated a specific individual or group of individuals to administer the technical and contractual requirements of the contract. So far as you are concerned, these individuals will represent the government for the life of the contract. They are your source of approval; your source of information; your source of discipline if discipline is needed.

A contract monitor will judge your company primarily through your representatives. This has many obvious ramifications. It is worth stressing that any meeting of your people with those of the contracting agency should be preceded by a thorough "in-house" briefing. This is particularly desirable for company personnel who do not have day-to-day contact with the program in question. These people should be made aware of the latest

developments in the contract, so that they may make a maximum contribution in the meeting. It is of course desirable that all of your actions and contacts with the project monitor be directed toward conveying a positive impression of interest, knowledge, and enthusiasm for the program.

Corporate Communications: An extension of the personal element is the problem of communications and the corporate image. Certainly you should keep your lines of communication with your project monitor and his agency clear. To this end, it is wise to establish one central point of communication for all administrative matters relating to government contracts,

In the Research Division of NRC, this point is the Contracts Office. All communications to a project monitor or his agency that have any bearing on the contractual requirements go through this office. Conversely, this office is also the receiving and filing point for all contractual correspondence.

This in no way is intended as a device to separate the project manager from his technical counterpart in the Defense Department agency, which would impede technical communications. To the contrary, there is much to be said for close—and direct—technical communication between the personnel involved. To circumvent any possible problems on this score, the agency in question should be indoctrinated to think of the Contracts Office as the office that speaks for the company insofar as the four corners of the contract are concerned. As a matter of course, the government agency is notified that the Contracts Office is the contractual or administrative contact and that the program manager on the staff should be contacted for all questions of a technical nature.

This procedure is comparable to that employed by the government, One man is usually designated as project monitor, and is assigned the responsibility for day-to-day guidance and control of the contract. However, the government makes it quite clear that this individual is not authorized to bind the government contractually, or to make contractual changes; such authority rests with the contracting officer.

Once the contact points have been set up and understood, the problem is one of maintaining good communications with the agency and the monitor. Periodic progress reports alone are never wholly satisfactory. Telephone calls are certainly in order at frequent intervals, if for no other reason than to make sure that the progress reports were fully understood. Frequent contacts go a long way toward assuring that everyone concerned is operating on the same wavelength.

Another part of communications involves personal contact and visits to the contracting agency. There is no substitute for it—it is the best way to get the message across. At the same time it permits you to become more familiar with the agency and its problems, both technical and administrative.

Presentations: One of the most common devices used in communication is the "presentation." This

may be anything from a straightforward discussion of a project at the agency, to fairly elaborate displays of information through the use of board artwork or motion pictures.

Presentations carry a fairly extensive amount of information concerning your project and organization out to the agency. It might be argued that this should not be necessary, since the project monitor should visit you frequently. Unfortunately, travel funds are always in short supply, so that many monitors cannot visit contractors as frequently as they might wish. Also, at any one agency there are probably several individuals or groups with some interest in your contract. A presentation at the agency therefore assures that all personnel concerned at the agency are given an up-to-date review of the project. There is also, unquestionably, some value to such a presentation (if properly done) from the standpoint of "selling" your capabilities.

A presentation offers an ideal opportunity for the project monitor to offer comments and suggestions on the work performed to date, and the work proposed for the future. This is particularly valuable in design or development projects where circumstances dictate radical changes in original concepts or philosophies.

A typical example of the foregoing occurred on a project in which a contractor spent several months working on an experimental device, following the lines of his proposal and the subsequent contract. As the project developed, each answer brought with it at least one new problem. It was not long before the project began to bog down, and the contractor finally had to admit to himself that a completely new approach was in order. The next step was a difficult one to contemplate—explaining the situation to the contracting agency. Openly admitting the fruitlessness of the present approach was an invitation to a contract termination. The alternative of delaying the announcement would merely postpone the inevitable with, probably, even more dire results.

The contractor requested permission to make a presentation at the agency, and prepared his material in two phases. The first was a straightforward description of the work performed to date, with particular emphasis on the effort spent attempting to overcome the numerous difficulties encountered. From this, it became clear that the contractor was justified in recommending abandonment of the original approach. The second phase of the presentation was a recommendation for a new approach, buttressed by evidence that it would not be subject to the troubles that had been encountered in the previous work. The upshot was that the contractor was given a new—and larger—contract to pursue the new approach.

In summary, two major points deserve to be reemphasized: 1. Understand the technical and administrative problems facing the monitor and his agency, and 2. Develop a conscientious, organized effort to establish and maintain good communications. To the extent that these factors are given attention, performance on existing contracts—and the probability of getting additional contracts—will be improved.

Tips and Techniques

Calculating Sines and Tangents

Sines and tangents of angles expressed in degrees can be rapidly approximated by the following method:

1. To find the approximate sine of an angle less than 30 deg, double the angle, subtract 0.15 times the result, then divide by 100. This linear approximation to the sine differs from the exact value by -2.55 per cent at 4 deg, and +2 per cent at 30 deg.

Example: Calculate the sine of 15 deg.

From the method shown, 2 (15) = 30; 30 (0.15) = 4.5; 30 - 4.5 = 25.5. Then, sin 15 deg = 25.5/100 = 0.255. Actual value is 0.2588.

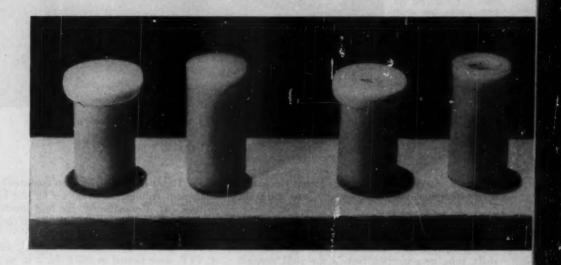
2. To calculate the approximate tangent of an angle below 25 deg, simply double the angle, subtract one-tenth of the result, then divide by 100. This linear approximation to the tangent differs from the exact value by less than 3.5 per cent for angles from 0 to 25 deg.

Example: Find the tangent of 15 deg.

From the method shown, 2 (15) = 30; 30 - 3 = 27. Then tan 15 deg = 27/100 = 0.270. Actual tangent is 0.2679.—John H. DeNeefe, Western Gear Corp., Lynwood, Calif.

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Technique Editor. Macunus Demion. Penton Bids. Circuland 13.0

Cold heading and upsetting are familiar methods used for assembling metal parts. But how about plastic components? For several of the thermoplastic materials, the answer is a definite "yes." This article summarizes results of recent tests made to adapt cold-heading of plastics to production-line fastening methods.



cold heading of plastics

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MOST thermoplastic materials can be cold headed to some degree, but among the most workable are the acetal and nylon resins. Data reported here pertain specifically to Delrin 500 acetal resin and Zytel 101 nylon resin. Other thermoplastics that can be used to form satisfactory heads for certain applications include acrylic, polyethylene, and fluorocarbon resins.

Cold workability of these materials is generally proportional to their elongation properties. Consequently, nylon, having greater elongation than acetal resins, can be cold formed into larger, or thin-

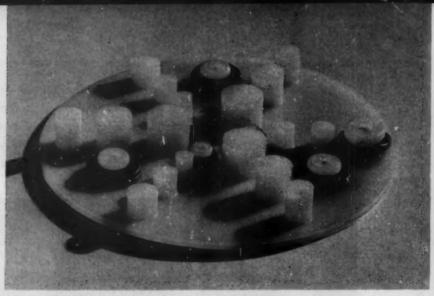


Fig. 1-Molded plaque used for testing nylon and acetal heading properties.

ner heads. Acrylic resins have the lowest elongation of the thermoplastics, and are the least formable.

Methods

Any method that uniformly loads the end of a shaft, tube, or projection beyond the yield strength of the material (while containing the shaft trunk) will permanently deform the material and form a head.

Two methods of head formation were used to obtain the design data reported here. The first consisted of placing the plastic shaft in a hole in a metal jig with about ½ in, of the shaft protruding above the jig surface. The jig was placed in an arbor press, and the necessary force was applied through a metal cap above the plastic shaft.

The second method utilized molded nylon and acetal plaques containing different sizes of projections, Fig. 1. Steel washers were placed on the shafts, and the heads were formed over the washers in an arbor press,

Standard punch-press equipment fitted with springloaded jigs can be used to assemble thermoplastic components such as pump impellers, Fig. 2, in production quantities.

A limited amount of work has been done in making rivets of nylon and acetal resins on conventional rivet-making machines. Although heads were formed, more development work is needed to produce satisfactory rivets.

Rate of Loading: The maximum effective rate of loading for cold-heading both nylon and acetal shafts at room temperature is on the order of 20 in. per min. Faster loading can cause cracking, or, especially for acetal resins, shattering.

Relaxation: Formed heads will not relax unless the service temperature exceeds the forming temperature. Heads formed at 73 F on compression-testing equipment required 20 to 30 sec for the load curve to level out. Consequently, the load should be held on the head for that amount of time to obtain minimum recovery.

Test shafts of nylon and acetal resin, cold headed at 73 F, were heated at 200 F for 2 hr to check for relaxation. The nylon heads recovered an average of 17 per cent of the original length of the shafts from which the heads were formed. Comparable recovery in the acetal heads was 5 per cent.

Forming Temperature: At 73 F, the compressive stress necessary to reach the yield point of nylon (at 2.5 per cent moisture) is 12,000 psi; acetal resins require 17,000 psi, Fig. 3.1 Total force required during heading increases, of course, because the shaft cross section becomes larger as the head is formed.

Nylon and acetal plaques were also headed at 200 F. The required load was found to be about 50 per cent of the load needed at 73 F. In addition to this advantage, heading of shafts above room temperature produces tighter fits.

Head Characteristics

Size: Only tubes comparable in size to those ordinarily used for fasteners were tested by cold heading. Sizes varied from 0.160 in, diam and 0.005 in wall to 0.500 in, diam and 0.061 in, wall.

Shape: When a compressive force is applied to a shaft, permanent deformation takes place at the minimum cross section which is not contained. The shaft can be tapered or bored out to reduce the cross section and concentrate the force at the area where heading is desired. If the shaft is contained in a jig or by another part, it is not necessary to reduce

iff. Raser, J. R. Knox, T. J. Linton, and R. E. Maler-"Structural Design of Plastics," Society of Plastics Engineers Journal, Vol. 18, No. 4, April 1960.

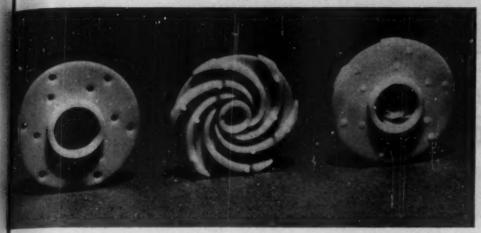


Fig. 2—Impeller for Flint & Walling submersible pump. The two parts at left are molded of acetal resin, and joined, right, by cold heading.

the cross section to form a head; however, a tighter joint is made when the cross section is reduced. The joint is tighter because less force is needed to form the head, subjecting the trunk of the shaft to less elastic deformation (which is regained after the pressure is released). The less the elastic recovery, the tighter the joint.

Length: Regainable deformation is also a function of shaft length. A short shaft is deformed less and therefore makes a tighter fit. Also, if only the portion of the shaft to be headed is heated before forming, shrinkage will tighten the joint. If a shaft is to be headed on both ends, the last head formed should be made using a smaller cross-sectional area than the first; otherwise, the first-formed head tends to shear off. This can be prevented, however, if

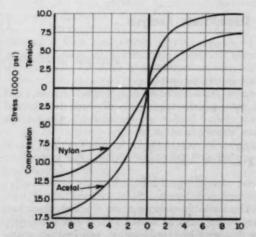


Fig. 3—Stress-strain curves for Zytel 101 (nylon) at 2.5 per cent moisture and Delrin 500 (acetal) resins at 73 F.

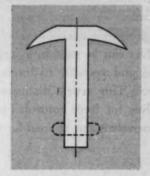


Fig. 4—Molded rivet-type fastener. Tight joint results when deformation under head is regained as load which forms head (dotted) is released.

the last compressive forces are not transmitted to the first head. Small-diameter shafts (under 1/4 in.) can be headed on both ends simultaneously.

The additional length of shaft necessary to form a satisfactory head varies with trunk diameter and with material. To determine this length, finished head dimensions and head volume are estimated. An equivalent volume must exist in the original length of shaft before heading.

Spring Effect: Joints can be made tighter by incorporating a spring effect in the head end of a molded rivet-type fastener, Fig. 4. The deformation under the head is regained when the load which forms the opposite head is released.

Tensile Strength: To determine head strength, heads on \(\gamma_8\)-in. diam shafts were pulled off by grasping a steel collar under the head with one grip and the shaft trunk with another grip. Heads with thicknesses varying from 0.035 to 0.150 in. were tested. Pull strength (not appreciably different within this thickness range) was about 50 per cent of the shear strength of the material.

How to use

Servovalves for Force Control

R. J. PROCACCINO, Project Engineer, Servocontrol Div., Oilgear Co., Waltham, Mass.

Hydraulic pressure has long been used to produce mechanical force. In the past, control of force was confined to pressure-reducing or relief valves. Now, however, servovalves can be used in a feedback system to provide precise and versatile hydraulic control of the mechanical force. This article discusses the details of using servovalves for force control. Future articles will show how servovalves can be used for velocity and position control.

O MEET the demands of load-maintaining systems, predetermined forces must be applied to a structure and sustained at the desired level regardless of load disturbances. In some systems, a high rate of response is required along with a wide range of force levels. Also, there may be a requirement for a force program.

The servovalve-controlled hydraulic cylinder used in a close-loop, force-feedback system provides a means of meeting all of these requirements.

Basic Force Loop

The basic force-control loop, Fig. 1, consists of a force-command device, servoamplifier, servovalve, load cylinder, and force-feedback transducer.

Load force is generated by the application of a differential pressure across the piston of the load cylinder. Differential pressure is established by the displacement of the servovalve in response to an amplified electrical error signal. A force transducer senses load force and produces a proportional voltage which is compared with the force-command voltage. Any difference in these voltages creates an error signal which displaces the servovalve until the cylinder differential pressure produces an output

force equal to that prescribed by the input command.

Systems of this type contain no integrator in the open loop. Therefore, they are classified as force regulators rather than true servosystems. An error voltage is required at the servoamplifier input to maintain an output-load force.

Steady-State Analysis

In a regulator-type system, loop error is approximately inversely proportional to open-loop gain. This criterion establishes a value for the minimum static gain of the system.

In a force-feedback type control system, load spring is usually appreciable. If piston leakage and load viscous friction are considered negligible, the force transfer function is¹

$$\frac{F_r(s)}{X(s)} = \left[A \frac{C_1}{C_2} \left(\frac{M_2}{K_2} S^2 + 1 \right) \right] / \left[\frac{CM_2}{K_2 C_2} S^3 + \frac{M_2}{K_2} S^2 + \frac{CK_2 + A^2}{K_2 C_2} S + 1 \right]$$
(1)

The static open-loop gain for the basic-force loop may be obtained by setting S = 0 and multiplying by the amplifier, torque-motor, and feedback-trans-

References are tabulated at end of article.

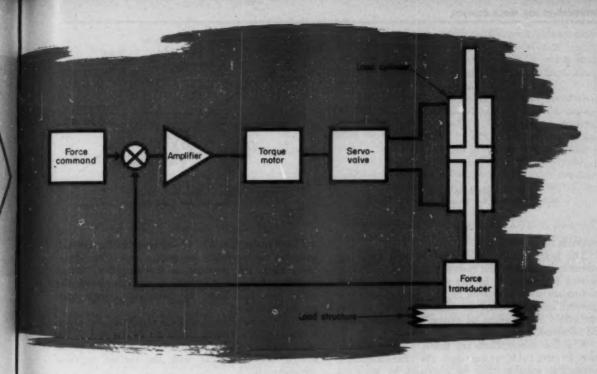


Fig. 1-Basic force loop.

ducer static-gain constants, Ka, Kt, and Kp. Thus,

$$R_{\rm el} = K_a K_i K_f A \frac{C_1}{C_2} \tag{2}$$

Ratio C_1/C_2 is the static-pressure-gain characteristic of the servovalve.

Thus, the basic problem in meeting the static-accuracy requirement is to establish the value of $K_{\rm el} = 1/{\rm fractional~error}$.

Dynamic Analysis

For a static-type load maintainer, a minimum loading rate is usually specified along with a requirement for small overshoots. Large overshoots may be destructive to the load.

The loading-rate response to a step-input command, and the degree of overshoot, can be estimated by standard servo analysis techniques from the openloop response of the system.

Equation 1, when multiplied by the transfer functions of the amplifier, torque more, and feedback transducer, becomes the open-loop transfer function of the basic force-feedback loop.

The denominator of Equation 1 is a cubic algebraic equation. To determine the poles, the cubic

Nomenclature

A = Piston area, sq in.

B = Bulk modulus of oil, psi

= 2 × 10⁸ in Practical Example

C =Compressibility coefficient of oil, cu in. per psi

 $C_1 =$ Flow-gain coefficient of valve, cu in. per sec per in.

 $C_2 =$ Pressure coefficient of valve, cu in. per sec per psi

F, = Piston force, lb

Ka = Gain constant of amplifier, ma per v

 $K_1 = Gain constant of feedback transducer, v per lb$

Kol = Static open-loop gain constant

 $K_t = Gain$ constant of torque motor, in. per ma

 $K_2 =$ Load-spring constant, lb per in.

 $K_{2}' = \text{Load-spring constant, lb per in.}$

 M_m = Ratio of closed-loop maximum value to value at zero frequency

 $M_2 = \text{Load mass, lb per in. per sec}^2$

 $P_m = Maximum pressure, psi$

P. Supply pressure, psi

 $Q_m = Maximum$ valve flow, cu in. per sec

 $V_m =$ Maximum piston velocity, in. per sec

 $V_1 =$ Volume of oil on one side of load piston, cu in.

 V_2 = Volume of oil on other side of load piston, cu in.

X =Valve displacement, in.

? = Ratio of actual damping to critical damping

 ω_e = Frequency at which open-loop gain = 1, rad per sec

 ω_1 = Lowest break frequency, rad per sec

ω₂ = Load spring mass resonant frequency, rad per sec

 ω_3 = Oil and load spring mass resonant frequency, rad

ω₆ = Filter break frequency, rad per sec

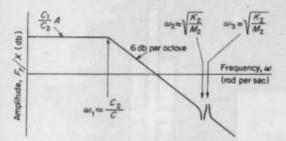


Fig. 2—Open-loop Bode diagram for Case 1.

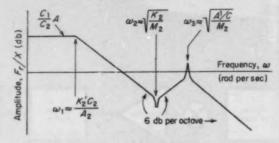


Fig. 3—Open-loop Bode diagram for Case 2.

equation must be factored.

The poles can be determined by first assigning numerical values to the system parameters and then solving for the roots by the standard mathematical techniques used for cubics of this type. However, a general solution would be more desirable, so that the effect of variations of system parameters could be discerned.

If a few assumptions are made, a general solution for the cubic, rather than the time-consuming numerical solution, can be obtained by standard mathematical techniques.

Case 1: If the load spring is assumed much larger than the effective spring constant of the oil, the resulting roots are approximately equal to $-C_2/C$ and $\pm i(K_2/M_2)$ %.

Examination of the numerator of the transfer function shows a zero also at $\pm i(K_2/M_2)^{\frac{1}{2}}$.

With this information, an open-loop Bode diagram, Fig. 2, can be drawn. This diagram shows the critical frequencies of the system.

The largest time constant of the system is determined by valve characteristics C_2 and oil compressibility C. Frequency ω_2 is determined by the resonance of the spring and the mass of the load. Frequency ω_3 is determined by the spring of the load and the spring of the oil in parallel, resonating with the mass of the load.

Case 2: If the effective oil spring is assumed much greater than the spring of the load, the resulting roots are approximately equal to $-K_2'C_2/A^2$ and $\pm j(A^2/CM_2)^{16}$.

A Bode plot for this case is shown in Fig. 3.

The first break frequency is directly proportional to the load spring. Case 2 is more common in actual practice.

Fig. 2 and 3 show the two extreme conditions of spring. In these two cases, all parameters except load-spring values are the same.

As the relative values of load spring and oil spring change from the condition in Case 1 to the condition in Case 2 the following changes take place. Assume $K_2 >> A^2/C >> K_2'$

- 1. Frequencies ω_1 , ω_2 , and ω_3 decrease.
- 2. Separation between w2 and w3 increases.

The transfer function as expressed in Equation 1 indicates no possibility for system instability. However, when the response of the amplifier, torque motor, and feedback transducer are considered, the phase lags introduced by these components may permit instability.

From the complete open-loop amplitude and phase response of the system it can be determined if the characteristics such as gain crossover and phase margin are compatible with the desired response requirements.

Equation 1 shows that the load spring and mass are important factors in determining the response of the system.

In most systems, the load mass should be kept low. The resulting high value of wa helps avoid system instability.

For systems where the response requirements are low, the load resonance may be maintained at a value high enough above the crossover frequency so that stability problems are not introduced.

For systems where fast response is required, cascade electrical-network compensation may be employed to allow higher-gain crossover frequencies, but yet maintain the proper phase shift and attenuation for stability.

Practical Example

Assume that the problem is to design a load-maintaining system capable of producing forces to a maximum of 20,000 lb in either tension or compression. The system shall be accurate to within ±5 per cent of the desired force-input command.

The system shall control force over a stroke of 4 in. and shall operate with spring loads that range from 5000 lb per in. to 100,000 lb per in. Maximum load structure weight shall be 1000 lb.

Maximum loading time constant shall be 10 sec with no more than 10 per cent overshoot.

Assume that a 2500-psi, pressure-regulated hydraulic supply is available.

Cylinder Selection: Because of saturation in the static-pressure-gain characteristic at load pressures approaching the supply pressure, Fig. 4, the system should operate to approximately 95 per cent of P_s.

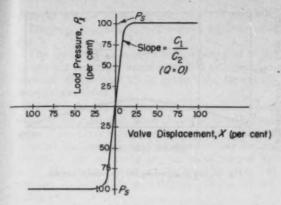


Fig. 4-Static-pressure-gain characteristic.

Operation beyond this point produces a sharp decrease in system gain and accuracy. The minimum differential area of the piston can be computed from the maximum operating pressure and maximum required load force. $A = F_r/P_m = 20,000/(0.95 \times 2500) = 8.4 \text{ sq in.}$

A 4-in. diameter, double-ended cylinder with a 2-in. diameter rod meets this requirement. A cylinder with low breakaway friction should be selected for smooth operation.

Valve Selection: To meet the loading-time requirement, the maximum piston velocity must be calculated, using the minimum value of the load spring.

An ideal loading characteristic, with a time constant of 10 sec with no overshoot, would be an exponential curve, Fig. 5.

For a 5000 lb per in. spring, the maximum load of 20,000 lb is attained in 4 in. of stroke. Maximum velocity V_m occurs at the initial slope of the loading curve. Slope = 4/10 = 0.4 in. per sec. Maximum flow $Q_m = V_m A = 0.4 \times 9.4 = 3.75$ cu in. per sec.

At 63 per cent of the maximum load, a pressure required across the load = 0.63 × 2400 = 1500 psi. Although lower values of differential load pres-

sure are required at smaller deflections, assume only 1000 psi is available across the servovalve, to insure adequate valve-flow capacity. Thus, a valve that provides approximately 1 gpm with a 1000-psi drop should be selected.

Select, for example, a swing-plate type servovalve which has the required flow along with a highly linear static-pressure-gain characteristic. Assume that, for this valve, $C_1 = 700$ cu in. per sec per in. and $C_2 = 4.18 \times 10^{-4}$ cu in. per sec per psi. Static-pressure gain is $C_1/C_2 = 1.67 \times 10^6$ lb per cu in.

The torque motor used to open this valve requires a current of 150 ma for a deflection of 0.015 in. Thus $K_t = 0.015/150 = 10^{-4}$ in. per ma.

Force-Feedback Transducer: A 25,000-lb load cell is selected as the feedback transducer. A typical output signal is 10 my for maximum load with a 5-v excitation. Thus, load-cell gain is $K_f = 0.01/25,000 = 4 \times 10^{-7}$ v per lb.

Static Characteristics: To obtain a static accuracy of ± 5 per cent, the minimum static open-loop gain must be $K_{ol} = 1/0.05 = 20$. A gain requirement of 25 is selected to allow for other small errors that may occur in the system.

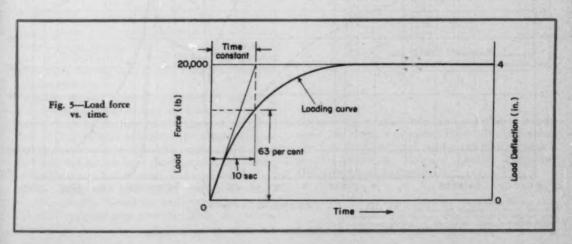
Since the gain of other components in the loop has been established, the minimum amplifier gain can be determined from Equation 2: $K_0 = 25/10^{-4} \times 4 \times 10^{-7} \times 9.4 \times 1.67 \times 10^{8}) = 4 \times 10^{4}$ ma per v.

Dynamic Characteristics: To determine critical frequencies ω_1 and ω_2 , the oil compressibility must first be calculated. Assume that the servovalve will be manifolded to the cylinder so that hydraulic control-line elasticity may be neglected.

The oil compressibility is $^2C = V_1V_2/(V_1 + V_2)B$. A plot of oil compressibility versus piston stroke is shown in Fig. 6.

For a 4-in. working stroke, a cylinder with a stroke of 6 in. should be selected to allow operation at a distance of 1 in. from the cylinder stop.

Over this operating range, the values of the calculated maximum and minimum compressibility are



 7×10^{-6} cu in. per sec per psi and 3.9 \times 10⁻⁶ cu in. per sec per psi.

The calculated maximum and minimum oil-spring values are $A^2/C = 22.6 \times 10^8$ lb per in. and 12.6 \times 10⁸ lb per in.

A comparison of these values and the range of load spring $K_3(5000 \text{ lb per in.})$ to 100,000 lb per in.) over which the system must operate shows that $A^2/C >> K_3$. Thus, $\omega_1 \approx K_3C_2/A^2$. For a load spring of 100,000 lb per in., $\omega_1 = 10^8 \times 4.18 \times 10^{-4}/9.4 = 0.475$ rad per sec. For a load spring of 5000 lb per in., $\omega_1 = 0.024$ rad per sec.

With an open-loop gain of 25, open-loop crossover frequency ω_0 can be determined. This value is the frequency at which open-loop gain is 1.8 Thus, $\omega_0 = 25 \times 0.475 = 12$ rad per sec for the 100,000 lb per in. spring and $\omega_0 = 25 \times 0.024 = 0.6$ rad per sec for the 5000 lb per in. spring.

For a system with an open-loop response of this type, the time to respond to a input step function can be related to the gain crossover frequency. That is, the time to reach 63 per cent of the final output is approximately equal to $1/\omega_{e}$.

The system can be thought of as having a time constant of $1/\omega_e$ sec. Thus, $1/\omega_e = 0.125$ sec for the 100,000 per in. spring and 1.67 sec for the 5000 lb per in. spring.

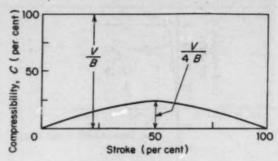


Fig. 6-Oil compressibility vs. piston stroke.

This response time is satisfactory, since it is considerably less than the I0-sec specified requirement. Actual system response will be somewhat longer than the above times due to the limitation of valve flow.

If the calculated time constants were too low, the system gain would have to be increased.

Damping: To determine whether the system will have less than a 10 per cent overshoot during a response to step inputs, the phase response of the open-loop transfer function must be investigated. As an approximation, the phase margin of the system for this degree of damping should be no less

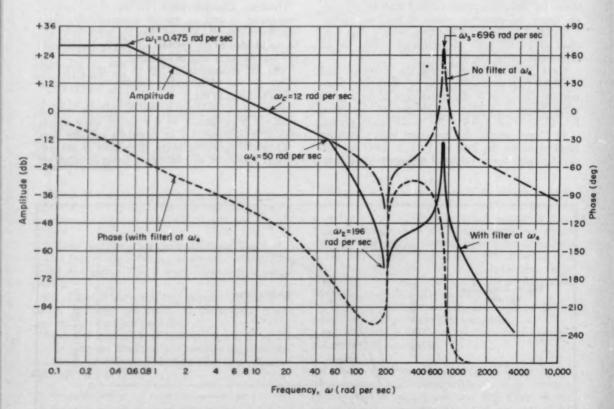


Fig. 7-Open-loop Bode diagram for 100,000 lb per in. spring.

than 45 deg (or phase lag less than 135 deg).4

Frequencies ω_2 and ω_3 will depend on load mass, Fig. 3.

The resonance at ω_2 contributes phase lead to the system but causes an increase in gain at higher frequencies. If the peak at ω_3 is too high, system instability may result.

In this instance, the most difficult situation would occur at the maximum value of ω_0 and the minimum value of ω_0 . These frequencies occur at the maximum value of load spring. The calculated values for the 100,000 lb per in. spring are: $\omega_0 = 12$ rad per sec; $\omega_2 = (K_2/M_2)\% = [10^5/(1000/386)]\% = 196$ rad per sec; $\omega_0 = [12.6 \times 10^5/(1000/386)]\% = 696$ rad per sec.

Damping ratio ζ at ω_3 as determined from Equation 1 is $\zeta = (C_2/2A)(M_2/C)\% = (4 \times 10^{-4}/2 \times 9.4)(1000 \times 7 \times 10^{-5}/386)\% = 0.0041$. Addi-

tionally, M_m ≈ 1/2ζ.4

The resonant peak M_m , at ω_0 would, in this case, extend above the 0 db axis of Fig. 3. Second-order effects which have not been considered contribute enough phase lag at ω_0 to make the system unstable. If it is assumed that instability may occur at ω_0 , yet second-order attenuation and phase effects are neglected for simplicity, a reasonable design can be obtained.

To reduce the gain at ω_3 , a cascade electrical network with a double break at some frequency, ω_4 , lower than ω_3 can be inserted. This network serves as a low-pass filter and has a transfer function equal to $1/(S/\omega_4 + 1)^2$.

Frequency ω_4 is selected at 50 rad per sec. Thus, the allowable phase lag at ω_0 is not exceeded; yet, the attenuation at ω_3 is sufficient to reduce the peak below 0 db.

The resulting Bode diagram, Fig. 7, of the openloop response using the 100,000 lb per in. spring indicates a stable system.

Phase lag at crossover is less than 135 deg, so less than 10 per cent overshoot should occur in the response of the system. For all other parameter changes, the system will meet the specifications.

▶ Conclusions

This design problem, although not too demanding in system requirement, points out the difficulties introduced by the variable-load characteristics often met in force-control systems. System design has to be more flexible than in the position-control system, for example.

In the example, system specifications were met over the entire range of load variation with a fixed gain setting and fixed electrical compensation. Often this result is difficult to achieve. In many instances, the gain setting and electrical compensation must be readjusted as the load characteristics are varied, to maintain required accuracy and response.

The simplifying assumptions that were made would probably necessitate minor changes in the electrical compensating networks after the system is tested.

The frequency response of the amplifier and torque motor, for example, were taken to be flat. In practice, however, there would be attenuation in these components at higher frequencies. This attenuation might have to be considered in the calculations. Piston leakage, "stiction," and load damping were not considered. If these effects are appreciable, then they must be considered in the system design.

The example system was designed to respond to step input commands. If a programmed-type input were desired, a faster response might be required. In this case, the dynamic design becomes more complex. To successfully stabilize systems of this type, some type of lead compensation may be needed.

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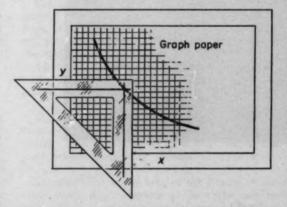
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Tips and Techniques

Plotting Curves

A pair of lines scribed along two edges of a triangle make a handy guide for plotting or reading curves on co-ordinate paper. The intersection of the scribed lines is placed on the point to be read, and corresponding values are read from the axes.



For plotting, a small hole can be drilled at the intersection of the two scribed lines. The x-y values are then lined up, and points are marked with a pencil.—Joseph S. Morgan, Electric Typewriter Div., IBM Corp., Lexington, Ky.

Do you have a helpful tip or technique for our other readers? You'll receive ten dellars or more for each published contribution. Send a short description plu drawings, tables, or photos to: Tips and Technique. Mattern Baston, Pendon Bidg., Civeland 13.



EARL E. WELLBORN Omaha, Nebr.

Comfort-Conditioned Cabs

Since the operator has a direct effect on the productivity of many off-the-road vehicles, operator comfort becomes an important factor in obtaining maximum productivity. Thus, comfortable cabs—heated or cooled, if necessary—often can be justified on an economic basis, rather than as a luxury feature.

TO provide maximum comfort the operator must be enclosed in a protective cab in which the air can be mechanically controlled. At the same time, the cab must not interfere with performance of his regular duties nor add to his discomfort. This article discusses the factors that must be considered in both the cab and the air-conditioning system to provide the optimum-comfort environment.

Requirements

Cab: The relative importance of each of these requirements will depend upon the expected operating conditions of the vehicle. However, all these items should be considered.

STRUCTURAL RIGIDITY: Although minimum weight is desirable in some applications, it should not be obtained at the expense of structural rigidity. Many of the other requirements cannot be met without this rigidity.

The cab should be anchored to the vehicle at points where it will be least affected by vibration. A three-point mounting arrangement will help avoid the transmission of deflection of the vehicle when it is operated over uneven terrain.

Sound Deadening: A cab can act as such an effective sounding board for the noise and vibration

of the engine that the operator will literally feel as though he were "inside a bass drum."

For operator health and comfort, the noise level in normal operation should not exceed 90 decibels. Noise can be controlled by adequate support of sheet-metal panels, by insulation on the interior surfaces of the cab, or by vibration-absorbing pads between the attaching points of the cab and the vehicle frame.

VISIBILITY: To perform effectively, the operator must be able to see in all the required directions. In addition to usual straight ahead view, he may need to see to the rear, to the sides, or almost straight down.

GLARE: While additional glass area increases visibility, it also tends to increase glare and eyestrain. This disadvantage can be partially offset by use of tinted glass, dull finish within the cab, dark surface on the floor, and by tilting the glass areas slightly from the vertical.

Access: The operator should be able to enter and exit easily. The air-conditioning equipment in the cab should be located so that it will not be a safety hazard.

Additionally, the door should be arranged so that it can be opened quickly and easily in case the



operator has to abandon the cab hastily if the vehicle starts to upset.

ROLLOVER PROTECTION: Ideally, the cab structure should be adequate to resist crushing in an upset, in case the operator is unable to jump clear of the vehicle. However, since the cab would have to be adequate to support a major portion of the vehicle weight, it may be impractical to provide this amount of protection.

ADEQUATE WORK SPACE: The cab must be large enough to permit freedom of movement so that the operator can reach all the controls. Additionally,

none of the cab components should restrict the travel of, or access to, the control levers.

STANDING ROOM: To relieve fatigue, the operator should be able to stand while operating the vehicle. In some cases, a step-down well can be used to provide the extra headroom, thus decreasing the over-all height of the cab.

HEAT GAIN OR Loss: Regardless of whether the vehicle is to be used in hot or cold ambient temperatures, adequate insulation in the walls and roof will reduce heat transfer and the load on the heating or cooling equipment.

For hot-weather operation, the cab should also be well insulated from the heat of the engine.

SEALING: Four types of sealing problems must be considered: 1. Between the cab and the basic structure of the vehicle. 2. Around fixed windows. 3. Around control linkages or shafts. 4. Around access doors or movable windows.

The first two types of sealing can be easily accomplished, since there is no relative movement except for deflection of parts under load. However, control linkages can produce complex sealing problems, especially if their motion is other than pure rotational or reciprocating. In some cases, a bellows or boot-type sealing arrangement can be used. The access door is normally held by a simple slam-type latch. However, a cam-locking means would be more effective. The movable-window sealing problem is best solved by making the windows stationary. If adequate mechanical ventilation is provided, there is usually no justification for opening the windows.

COMPATIBILITY WITH MOUNTED EQUIPMENT: If additional equipment is to be mounted on the vehicle, the cab should be arranged so that it does not interfere with the installation or operation of the equipment.

Additionally, such factors as operator visibility, access, and work space must be provided for operation of the mounted equipment.

Air-Conditioning: Comfort of the human body depends upon air movement, temperature, and humidity. Thus, an effective air-conditioning system must provide for control of these variables within the cab.

HEATING: The waste heat of the engine is normally more than adequate to heat the cab interior. Thus, a relatively simple core-and-fan type heat exchanger will maintain the recommended cab temperature of 65 to 70 F.

To prevent fogging and icing of the windows, heated air should be directed against all the glass areas through which vision is essential.

Even though in a heated cab, the operator may wear heavy clothing during cold weather operation if it is necessary for him to get out "into the

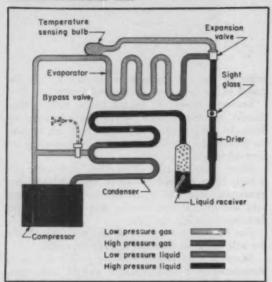


Fig. 1-Schematic diagram of a basic refrigeration system.

weather" frequently. In such cases, lower cab temperatures are advisable.

From a cold start, cab temperature should stabilize at the desired value within 10 to 15 min.

Cooling: For hot weather operation, the cab temperature should be maintained at 10 to 15 F below outside air temperature. The temperature rise inside an unoccupied cab ranges up to 33 per cent above ambient temperatures under normal warmweather conditions. Thus, for operation at 100 F ambient temperature, the refrigeration system should have capacity to reduce the cab temperature 40 to 50 F.

For many applications, a refrigeration capacity of 2 to $2\frac{1}{2}$ tons is required. However, the exact value depends upon cab design and operating conditions of the vehicle.

Pressurization: For operation in dusty conditions, pressurization is essential. Otherwise the cab becomes a dust trap. The required pressure varies with cab sealing effectiveness and with weather conditions. Normally, however, the cab pressure should exceed atmospheric pressure by 0.03 to 0.06 in. H₂O.

VENTILATION: Air movement ranks second in importance only to temperature. Air in the cab must have sufficient motion to provide uniformity in temperature and humidity without an objectionable draft. The air should be free of toxic, unhealthy, or disagreeable gases and fumes; and it should be relatively free from odors and dust.

A minimum of 10 cfm per person must be provided from an outside source to remove body heat, odors, and products of respiration. An additional 6 to 7 cfm are required if the operator smokes, However, to provide proper air movement, a total flow (fresh and recirculated) of 300 to 600 cfm is required.

Outside air is introduced through a filter system, heater, and evaporator.

Ventilation alone will satisfactorily condition the cab with ambient air temperatures of 45 to 60 F. Air being circulated for ventilation only, or for cooling and ventilation, should be discharged on or about the upper part of the operator's body, from a point relatively high in the cab.

Design Considerations

The expected operating conditions of the vehicle will determine many of the requirements of the cab and the air-conditioning system.

For example, a tractor intended only for arctic operation would require only the heating and the ventilating portions of the air-conditioning system. However, an agricultural or an earthmoving tractor might require the complete system for year-around operation.

Thus, expected ambient temperature, humidity, and dust conditions will help determine type, as well as capacity, of air-conditioning equipment required.

Location of the cab in relation to the engine of the vehicle will affect heating and cooling requirements. Additionally, the relative location may influence vibration problems, as well as the location of the components of the refrigeration system.

Since compressor speed affects the capacity of the refrigeration system, the normal operating speed of the engine must be used in determining system capacity. For example, many off-the-road vehicles operate at about 75 per cent of rated engine speed. Thus, the compressor speed must be estimated at a realistic value.

Available Equipment

In general, the cab must be designed for a specific installation. However, the air-conditioning components are normally available as off-the-shelf items. Here are factors to consider in selecting these components.

Heating: To provide a uniform temperature throughout the cab, the warmed air should be introduced near the cab floor. The flow of heated air should be directed toward the operator's feet and legs.

Heaters are available in wide range of size and capacity, with or without an attached fan. Fan motors are available for operation from 6, 12, 24, and 32 v power sources.

Cooling and Dehumidification: The refrigeration unit which provides temperature and humidity control during hot weather operation is a sealed system. The refrigerant is dichlorodifluoromethane, more commonly known as Freon or F-12. Its advantages include moderate operating pressures, good refrigerating effect, and non-toxicity. System capacity is the number of pounds of refrigerant required for a full charge.

The system must be kept clean and dry to pro-

vide satisfactory operation. Air must not be allowed to leak into the system because it lowers the efficiency and causes corrosion and oil sludging.

Refrigerating capacity is the rate of heat energy intake in tons of refrigeration every 24 hours. A standard commercial ton is equal to 288,000 Btu

per 24 hr or 200 Btu per min.

A basic refrigeration system is shown schematically in Fig. 1. Although this basic system may be modified in many ways to adapt it to a particular application, the operating principles remain the same.

COMPRESSOR: This device must withdraw the refrigerant from the evaporator to maintain the required reduced temperature and pressure. Secondly, it must compress the refrigerant to raise its temperature above that of the atmosphere.

The normally used types include: 1, Vane. 2. Twocycle reciprocating pistons. 3. Four-cycle reciprocating pistons. 4. Wobble plate with reciprocating

pistons.

Desirable compressor characteristics include: 1. Minimum size and weight. 2. Large capacity. 3. High efficiency. 4. Reliability. 5. Quietness and freedom from vibration. 6. Capable of high-speed operation.

CONDENSER: This component is essentially a heat exchanger which condenses the gaseous refrigerant to a liquid by passing air through the core. Location of the condenser depends upon engine performance, mounting space, and facilities to drive from the engine shaft or other power source.

If the cooling capacity of the engine is adequate to accept the additional heat load, the condenser may be located ahead of the radiator. Thus, the radiator provides mounting support and the engine fan provides air movement. However, if the engine cooling system does not have adequate additional capacity, the condenser cooling must be provided separately. Additional power will be required for a fan drive for air movement about the core.

EVAPORATOR: This heat exchanger removes heat from the space to be cooled. In a direct expansion system, the evaporator coils are normally placed directly in this area. The heat-removal capacity depends upon the temperature differential between the air passing over the coils and the boiling refrigerant inside the coils.

The "draw down" time required to stabilize conditions within a cab, which has been sitting unattended and well sealed until reaching a point of maximum temperature build-up inside, should be

no greater than 10 to 15 min.

PRESSURIZATION AND VENTILATION: There are two basic system designs: 1. A central system having only one fan for ventilation, heating, and cooling. 2. Individual fans, one being a part of the heater assembly and one a part of the evaporator assembly. The latter is also for ventilation only.

Factors which govern the location of components within the cab are: 1. Allowable space within cab 2. Location of air intake opening in cab. 3. Type of air ducts inside cab. 4. Means of powering ventilation fans. 5. Method of bringing refrigeration and heater lines inside cab. 6. Method of recirculation

Average Ca	b Spe	cificat	ions
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Dimensions		
Volume	100 cu ft	
Glass Area (tinted)	25 sq ft	
Heating System		
Capacity	15,000 to 30,000 Btu per hi	
Minimum Cab Temperature	65 F	
Time to Stable Temperature	10 to 15 min	
Refrigeration System		
Capacity .	2 to 2.5 tons	
Temperature Differential	50 F	
Time to Stable Temperature	10 to 15 min	
Power Required	4 to 8 hp	
Compressor Speed	400 to 4000 rpm	
Type of Refrigerant	F-12	
Ventilating System		
Maximum Delivery	600 efm	
Power Required	1 hp	
Maximum Recirculation	75 per cent	
Cab Pressure	0.03 to 0.06 in. H _g O	
Fitter System		
Capacity	3.0 grams per hr	
Service Interval	100 hr	
Maximum Allowable Pressure Drop	10 in. H ₂ O	

of air

Projection of the air-conditioning unit into the cab should be held to a minimum, both for operator convenience and safety.

The outside-air intake should be located so that it will be least affected by swirling air currents and dirt concentrations during normal or extreme operating conditions. Location of the air intake can directly affect the simplicity of design, degree of convenience, and manufacturing costs. When selecting a unit during the design stage of a cab, consideration should be given to providing the air passages as part of the cab—for example, within structural members.

The fan may be powered either electrically or mechanically from the vehicle engine. The ventilation fan should have sufficient capacity to deliver adequate air to the operator for heating, cooling, or ventilating, and to pressurize the cab interior.

A combination or mixed-flow type fan can be used if the required pressure is too high for an axial fan and too low for a centrifugal blower.

Controls should be simple and accessible to operator. An ample range for unusual conditions should be provided. In most applications, recirculation of a portion of the inside air is necessary. A manually-controlled, adjustable gate may be used to control the proportions of recirculated and fresh

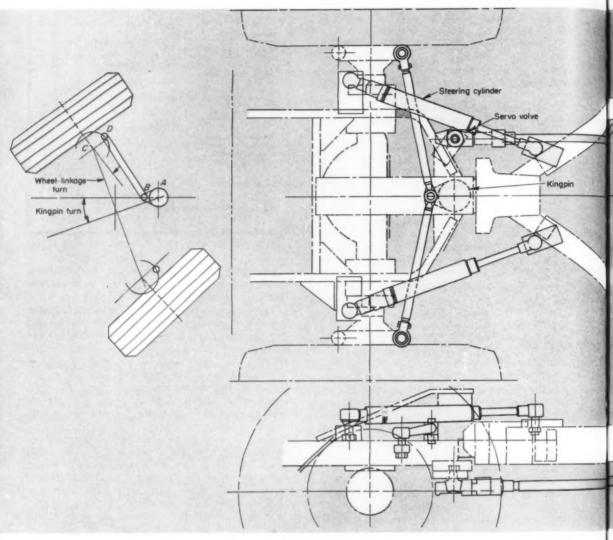
The air filter may be either an oil bath or dryelement type. The filter may be located upstream or downstream of the fan.

The filter should be located so that it is accessible for servicing. Its capacity should be adequate to permit servicing at the same interval as the oil filter on the vehicle engine. Normally this period is 100 hr of average operation.

ACKNOWLEDGMENT

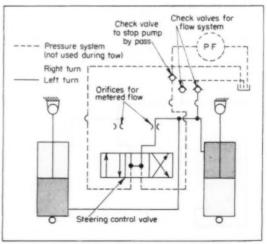
MACHINE DESIGN acknowledges with appreciation the cooperation of Allis-Chalmers Mfg. Co., Milwaukee, Wis., in supplying photos for this article.

KINGPIN STEERING

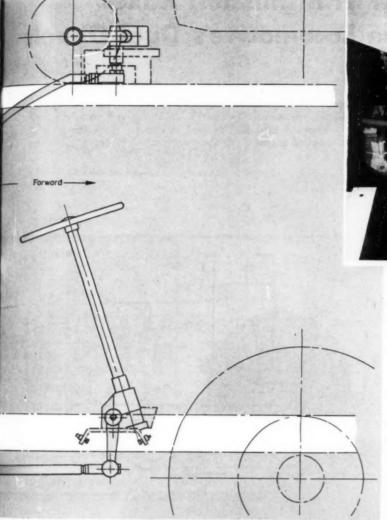


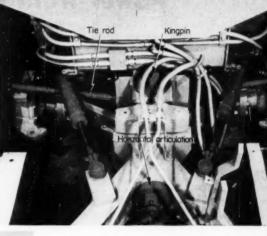
SHARP TURNS are no problem to a vehicle having a hybrid steering arrangement. Combining a center kingpin with individual wheel kingpins, it employs four-bar linkages to force the two sets of joints to turn together. Because projected service includes hauling the vehicle between jobs at highway speeds, a method had to be found to make the mechanism stable enough to track behind the towing vehicle.

ORIFICES pass fluid through the steering control valve at a controlled rate permitting the steering mechanism to respond to demands of the towing vehicle. Uncontrolled oscillations cannot force fluid to bypass the orifices because of check valves in sump lines. This permits the pistons to pump up enough pressure to effectively damp the oscillations. Check valve in the pump line stops pump bypass when the vehicle engine is shut off.



with an Added Twist





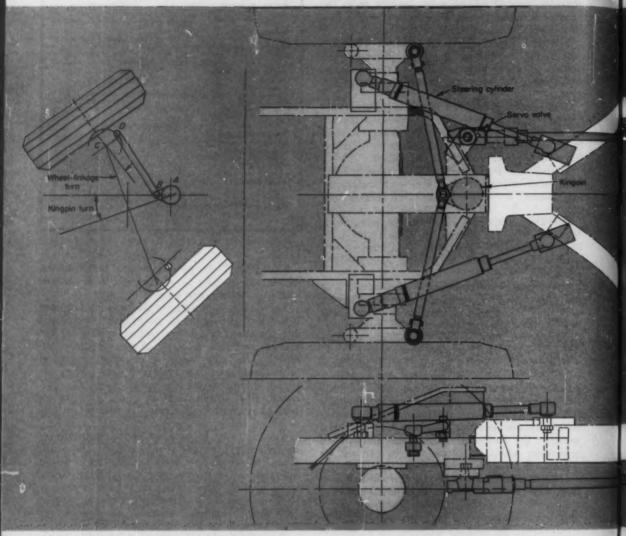
CROSSOVER four-bar linkages attached to each wheel transmit rotation from center kingpin to the wheels. Kingpin crank, which is common to both wheel linkages, turns with the front frame of the vehicle.

ARTICULATION of front and rear frames keep wheels on the ground and driving. Each pair of wheels has a differential, but there is no differential between front and rear.



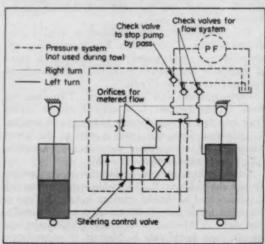
October 12, 1961

KINGPIN STEERING

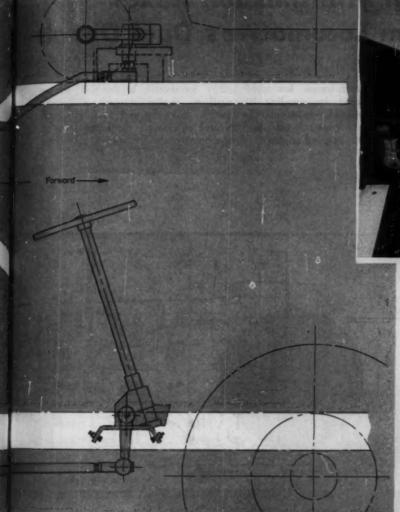


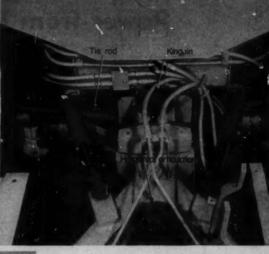
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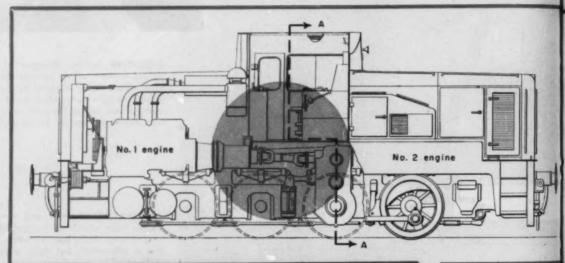
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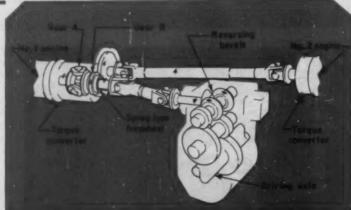


October 12, 1961

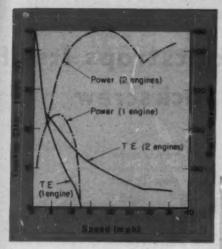
Differential Transmission Mixes Power from Locomotive's Dual Diesels

Power of high-torque low-speed utility locomotive is doubled during high-speed runs by coupling its auxiliary engine through a power-mixing differential. In normal yard work—humping and switching—and in starting, one engine is used near its peak efficiency. For highballing on the main line, a second engine is engaged to give usable torque at speeds up to 35 mph.

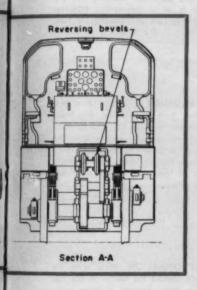


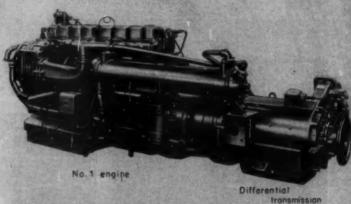


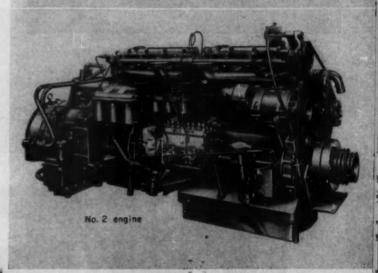
ENGINES are situated fore and aft of the engineer's cab. The power-mixing differential transmission is just forward of No. 1 engine. Power is transmitted to the driving axle through reversing bevel gears. When only one engine is used, gear B is locked by a sprag-type free wheel. Output from the transmission is through the differential spider.



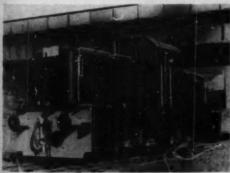
BEST HORSEPOWER output is gained from one engine at speeds up to 7 mph. Because specific fuel consumption is lower at open throttle, considerable economy is obtained by use of a relatively small engine working at full power. Addition of power from a standby engine more than doubles top speed of the locomotive. Designers claim efficiency above 70 per cent for most of the locomotive's range of operation.







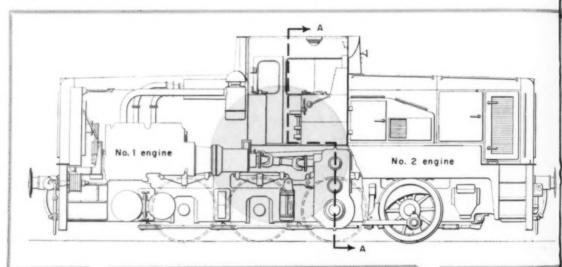
TRANSMISSIONS and engines for the locomotive are built by Rolls Royce Railway Traction Department, Shrewsbury, England. Type C&S diesel engines are rated at 311 hp at 1800 rpm. Each is fitted with a three-speed torque converter built under license from Twin Disc.

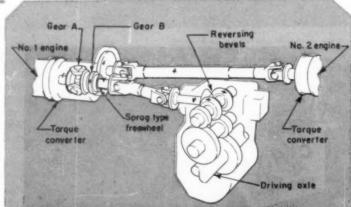


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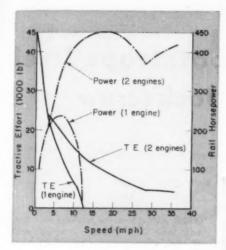
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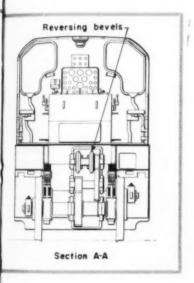


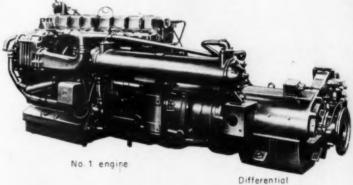
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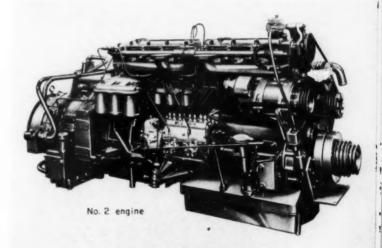
transmission



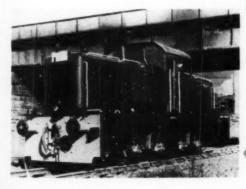
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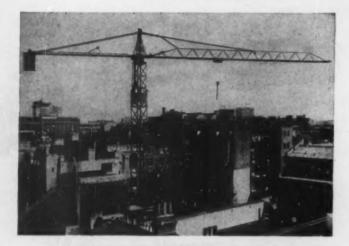
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Tower Crane Bootstraps Itself With Aid of a Jackscrew

ADDING SECTIONS to its tower as it climbs, a self-erecting crane uses a screw-and-beam mechanism to climb the main-mast box section it has just put in place. The same screw is used in first erection of the tower.



CRANE ARRIVES at the working site with mast base, inner mast, counter jib, and all motors in position for immediate operation. The inner mast is trunnion mounted in a horizontal position. First operation is to erect it, using the screw and beam to pull it into position. Halfway up, the counter jib is in a convenient position for bolting together the counter-jib ties.



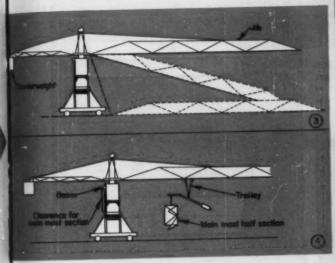
MAIN HOIST WINCH raises the jib in two stages. After it is in position, the hoist rope is reeved through the trolley and return block and rigging is complete. The screw raises the beam to its upper limit, and the crane delivers main mast sections to the top of the mast where they are bolted into place.

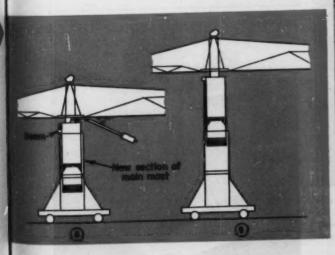
BOOTSTRAP OPERATION starts with the screw which lowers the beam to the top of the new mast section. Further rotation of the screw jacks the inner mast up through the new section. When clearance for the next section is achieved, lock brackets are inserted in the main mast, and the inner mast is lowered onto them. The beam is then raised to clear the new section which is put in place as before.

SLEWING MOTOR drives the screw. It has two sets of windings—a high-speed set slews the jib; a heavy-duty set operates the jacking screw. Thrust bearing for the screw is at the bottom, so weight of the inner mast is always carried in tension, thus avoiding thin-column problems.

PINGNON crane was designed in France for sale in England by George Cohen Sons & Co. Ltd., London.

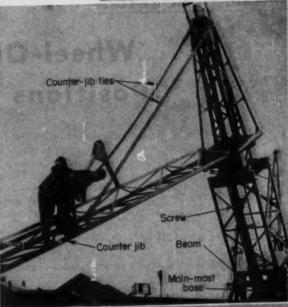
Counter jib ties Screen

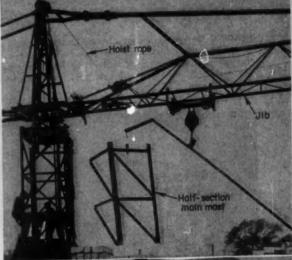




October 12, 1961

design in action

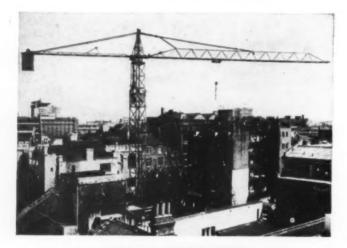






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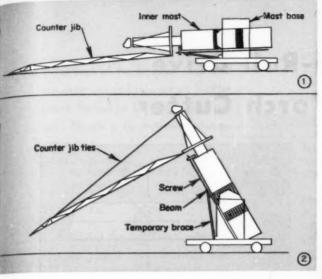


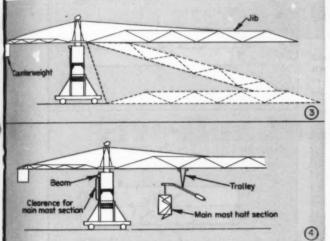
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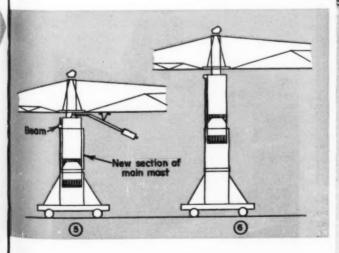
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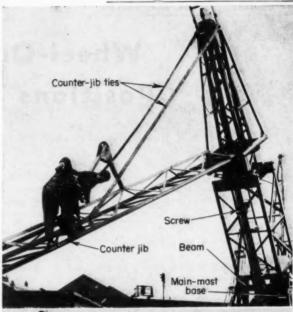


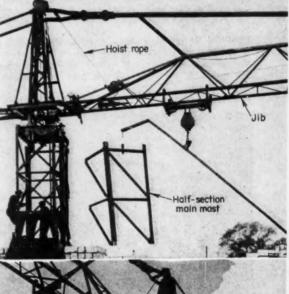


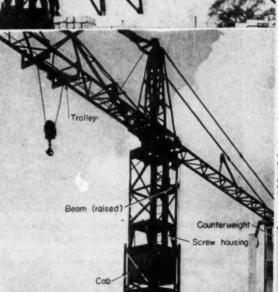


October 12, 1961

design in action





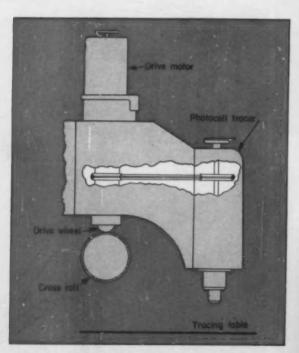


Wheel-On-Roll Drive Positions Torch Cutter

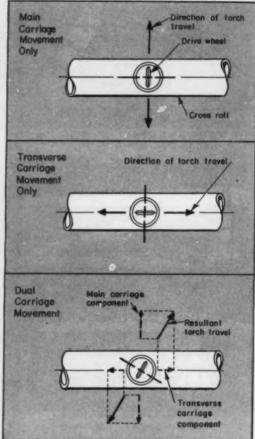
GROWING use of drawings instead of three-dimensional patterns demands that enough traction be given to the driving mechanisms of automatic torches to keep them from slipping as they overcome inertia and friction in the torch carriage. A new mechanism drives a wheel on a cross roll, and neither wheel nor roll comes in contact with the pattern table surface. It's one of the features in the CM-56 developed by the Linde Co., Div. of Union Carbide Corp., New York City.

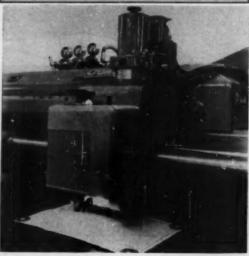
WHEEL acts like a driving gear to transmit rotation to the cross roll for motion of the main carriage. Transverse carriage, mounted on the main carriage, follows the wheel when it travels axially along the roll. When the wheel is in a diagonal position, the two motions combine to move the torches in the desired direction.

HEADING OF WHEEL is controlled by photocell tracer which determines the direction of the pattern line and corrects the wheel accordingly. A feature up for patent permits the tracer to make an oversize pass, compensating for width of kerf.



PATTERN FOLLOWER does not touch the table top at any point. Designers say wheel marks on the roll have no adverse effect on the output. Since the carriage moves slowly, not much power need be transmitted by the wheel-on-roll combination.





Motions of the five-bar loop and the many ways to constrain it offer great flexibility in mechanism design. Here's a co-ordinated design procedure:

- Determine a five-bar loop to bound any desired plane motion by an area.
- Establish the functional relationship that must exist between two nonadjacent links, to yield the desired motion.
- Couple these links together with a simple mechanism to match motion requirements.

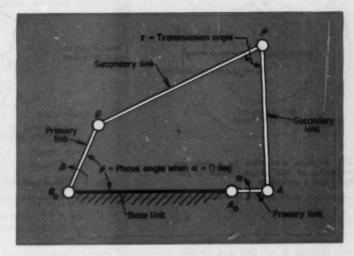


Fig. 1-Nomenclature for the five-bar loop.

Five-Bar Loop Synthesis

STANLEY E. ROSE

Senior Design Engineer General Electric Co. Phoenix, Ariz. I NCREASING complexity of modern devices is demanding sophisticated mechanisms to answer the challenge. This article demonstrates how the five-bar loop can be synthesized into mechanisms to generate prescribed motions. The word "loop" is used to recognize that five bars, merely pin connected at the ends to form a closed chain and permit relative movements between links, lack sufficient constraint for motion as a stable mechanism.

Loop Properties: Fig. 1 is a typical loop with A_0B_0 as the frame or base link. Links A_0A and B_0B are called primary because they are pivoted to the base and one of them is often the driving or input link.

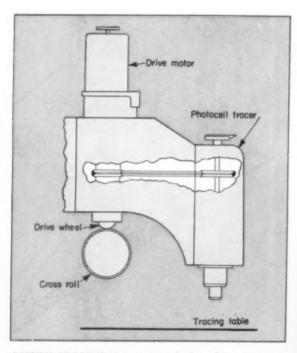
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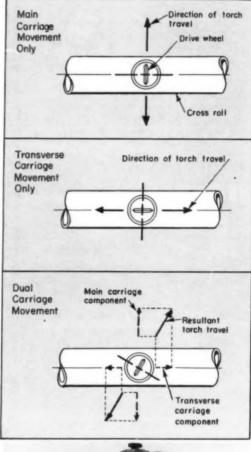
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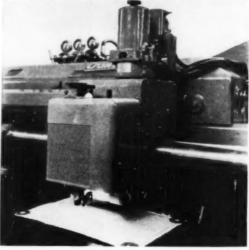
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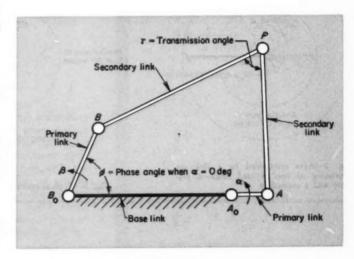


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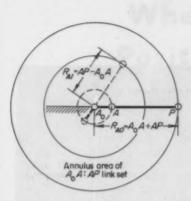


Fig. 2—Area controlled by a link set consisting of two pivoted links—a primary and a secondary.

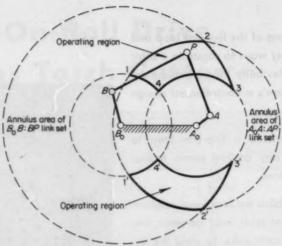


Fig. 3-Typical operating regions of a five-bar loop.

not become 0 or 180 deg at any position in the movement of P. Of immediate concern is the region to which the movement of point P is restricted.

A primary link and its adjacent secondary link, as $A_0A:AP$, are referred to as a link set. A single link set confines the excursions of a point P to an annulus area, Fig. 2. Point P has its maximum radial distance R_{A0} when the primary and secondary links of a set are collinear and extended.

The radial distance is R_{AI} and minimum when the secondary link folds back on the primary link. If a primary and its secondary link are equally long, $R_{AI} = 0$ and the area over which P can move is a circle of radius R_{AB} .

Similarly, link set $B_0B:BP$ limits the excursions of P to another annulus area. When the excursions of P are controlled by two link sets, as with a fivebar loop, the resulting total operating region of point P consists of an overlapping annulus area, or areas, Fig. 3. The two operating regions, 1-2-3-4, of Fig. 3 are symmetrical about base link A_0B_0 . If the dimensions of the five bars are such that a single region exists, it too is symmetrical about the base link.

Operating regions change rapidly with changes in link dimensions. But, they do more than define the total excursions possible for a point P. They indicate how link dimensions can be altered to confine P to regions of any desired size and shape. They are a design tool.

For example, a five-bar loop is easy to construct to confine movement of a point P to a prescribed operating region. Consider a given region as circumscribed by numbers 1, 2, 3, 4, Fig. 4. Perpendicular bisectors of lines 1-2 and 3-4 locate center A_0 ; the perpendicular bisectors of lines 2-3 and 1-4 locate B_0 . Dimensions of the primary links are then equal to half the difference in maximum and mini-

mum radii. That is, $A_0A = (R_{A0} - R_{AI})/2$ and $B_0B = (R_{B0} - R_{BI})/2$. Secondary links are equal to the maximum radii minus the dimensions of the corresponding primary links. Thus, $AP = R_{A0} - A_0A$ and $BP = R_{B0} - B_0B$.

Transmission angle τ varies as P moves throughout an operating region and may attain more than one value for a given location of P. Its minimum value occurs when A and B are nearest each other, while its maximum is attained with A and B farthest apart.

If τ is assigned a constant value, secondary links AP and BP form a rigid coupler and the five-bar loop reduces to a four-bar linkage, Fig. 1. Then, depending upon which is the input link, either angle A_0AB or angle B_0BA represents the new transmission angle which must be studied for limits. To couple any two adjacent links, either rigidly or in some prescribed manner, changes a loop into a stable mechanism.

A constrained mechanism also results if any two nonadjacent links are coupled together by some means. The coupling variables, however they may be defined, can assume many forms from a 1:1 gear ratio to variable ratio gears, linkages, and multiple cam couplings. This inherent flexibility of the five-bar loop plus a coupling thus nets mechanism possibilities with broad application.

In general, by controlling the motions of A and B with cams, P can be made to define any motion desired within an operating region and with any degree of precision, Fig. 3. The problem of synthesis then is to develop the best set of link proportions and a suitable cam coupling for the job at hand. Accordingly, after a region of motion is defined, synthesis entails little more than the straightforward design of a cam mechanism of acceptable proportions and degree of refinement.

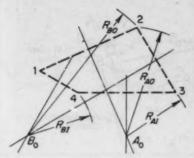


Fig. 4—Graphical determination of link-set proportions for a five-bar loop to circumscribe a given operating region.

On the other hand, if the coupling controlling the relative motions of A and B is gears and/or linkages, the true movement of P within the region may only approximate the desired movement. Synthesis may entail comparison of the true with the desired movements to get a mechanism of acceptable accuracy. At times, such trial-and-error development may be burdensome. Also, the methods of precision points, covered elsewhere, 1,2,3,4 can be applied to coupling design, particularly if extreme accuracy is essential.

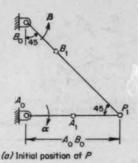
Designwise, the advantage of a coupling in conjunction with the loop comes about because the loop can be used to indicate the type of kinematic relationship needed from the coupling. Often this relationship can be linear or simple, and a mechanical device having the required relationship can be chosen readily. Afterward, the loop and coupling are examined for adequacy of over-all movement. Just how this is done is illustrated later by examples.

Four-bar mechanisms with equal cranks often serve well as couplings. They are the equivalent in constant ratio to gear and chain drives. Equal-crank mechanisms are simpler than four-bar mechanisms with unequal cranks.^{5,6} Variable-ratio gear pairs,^{7,8,9,10} though presently limited in application as couplers of five-bar loops, have motion characteristics worthy of examination.

Forced Synthesis: Forcing the five-bar loop means to move P through a required function, observe the relative motions of nonadjacent links, and then couple a chosen pair of links by a convenient means to net the required motion of P. Thus, depending upon the method of coupling chosen, a useful mechanism results with a minimum of six links.

Layout to scale on a drawing board is a practical way to describe an operating region to encompass a specified function and to begin the design of a mechanism for a specific duty. The next step is to fix the dimensions of a suitable five-bar loop. Fig. 4 and its construction set forth a geometrical method of proportioning links. Other ways are mentioned in the examples.

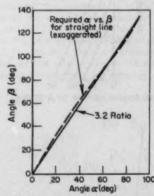
Magnitudes of the transmission angle τ may well be examined as soon as a set of loop dimensions is established. A desirable range of transmission angle is from 40 to 140 deg. 11.12 Any set of loop dimensions with transmission angles near 0 or 180



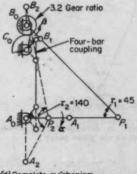




(b) Final position of P



(c) Angle relations



(d) Complete mechanism

Fig. 5—Geometry and development of a mechanism for straight-line displacement between two given points.

(b) Location of A and A

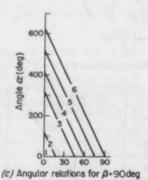




Fig. 6—Steps in development of five-bar loop to contact six given points.

deg should be discarded. See Example 3 for further discussion on limits.

Selection of a type of coupling may seem the most difficult design step because of the great variety of devices from which to choose. Moreover, coupling

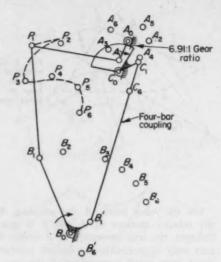


Fig. 7—Five-bar mechanism resulting from the solution of Example 2.

selection and verification become more difficult as the requirements for precision may be tightened.

The process of forcing a mechanism can best be explained with the aid of examples. The examples are typical and illustrate many of the steps required for a design solution. In general, an example shows how each link set may be considered separately at first and then in combination with a second link set to comprise a five-bar loop. A pair of nonadjacent links is chosen for coupling together. Motion requirements of the coupling are determined, a coupling type is chosen, and the kinematic performance of the loop and coupling examined to complete the design. Strict adherence to this procedure is not mandatory, of course.

The examples illustrate as clearly as possible basic techniques of synthesis by the forced method. It is not implied that they represent the best or only solutions to the problems presented.

Example 1, Straight-Line Motion: To illustrate the concept of forcing the five-bar loop to generate a required function, consider Fig. 5a. Initially, the geometry comprises a 45 deg triangle A_0B_0P with A_0 and B_0 representing given pivot points on the frame. It is required that P travel a straight line from P_1 to P_2 , a distance of $(^34)A_0B_0$, during 90 deg clockwise rotation of input link A_0A_1 .

Input link set A_0A : AP is fixed by the problem statement, and once the angle of rotation of β is chosen the driven link set is also defined. Total movement of angle β is arbitrarily chosen as 135 deg. Thus, from the geometry at the extreme positions, the link proportions are: $A_0B_0 = 1$ unit, $A_0A = 0.469$ unit, AP = 0.531 unit, $B_0B = 0.194$ unit, and BP = 1.22 unit.

With these link proportions, P is moved in the required straight-line path from P_1 to P_2 , Fig. 5b. Angles α and β are measured and plotted, Fig. 5c. Angular relationship of other nonadjacent links could also have been considered.

The plot indicates the nature of the coupling required between primary links to generate a straight line between P_1 and P_2 . At this stage the feasibility of a particular geometry is generally settled. If this relationship had not been practical, other link sets would be considered or the

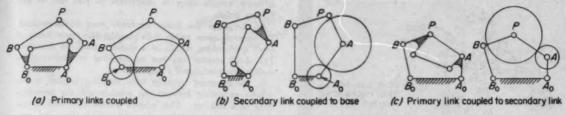


Fig. 8-Three inversions of typical five-bar mechanisms.

link proportions changed. In this case, the resultant plot closely approximates a straight line with a slope of 3:2; hence, a simple gear train with a 3:2 ratio approximates the P locus required. A 3:2 train, inserted into the linkage geometry, shows a maximum deviation of P from the required straight-line path of 0.6 per cent of the total travel with respect to datum points at P_1 , P_2 , and at $\alpha=60$ deg. This accuracy was considered adequate and led to the mechanism of Fig. 5d. Thus, the coupling device consists of a gear sector of 3:2 ratio, pivoted at C_0 , plus a four-bar linkage of 1:1 ratio. A chain drive would also apply here.

If the accuracy realized by the 3:2 gearing were not considered adequate, the shape of the plot indicates that a four-bar coupling could be developed to produce the P locus with extreme accuracy. Development of the proportions of the coupling could follow any of the well-known techniques. 2:3.5 This example demonstrates the strict limitations often placed upon a mechanism and the means whereby the function is generated by selection of the coupling between nonadjacent links.

Example 2, Contact Six Points: In Fig. 6a, points P_1 to P_6 must be contacted in order. Although a cam-link system could readily be developed to trace this locus exactly, the specification for the mechanism expressly stated that cams be avoided if possible.

Preliminary study of the function indicates that the locus of points does not lend itself readily to generation by a linkage system. Flowever, the locus may be studied with two geometrical concepts in mind: Location of two link sets operating at essentially 90 deg to each other, and locating the center of at least one link set so that its maximum and minimum radii contact as many of the points as possible. The former assures reasonable transmission angles while the latter inherently renders accuracy. As each set of pivot locations is considered, the relative angular relationships between the primary links are also considered, as they must later be coupled together by a reasonable means.

With these design guides, Ao is located as in Fig. 6b. Note that RAO intersects P3 and that RAI intersects P2 and Ps. Dimensions of one link set are thus determined. Another preliminary study also indicates that this location of rotation center Ao is such that the angular displacements between adjacent values of A reasonably follow displacements in a direction at right angles to the general orientation of AP. The direction of rotation and sequence of A positions are then determined to match these requirements as closely as possible. Note that here there are two angular positions possible for A1, A4, and A6. Their locations are dictated by the approximately 180-deg rotation of A from A2 to A3. For example, As could have been located at almost one revolution away from As instead of the position shown. This would mean that the second link set would move approximately twice the P2 to P3 distance in moving from P5 to P6. Since the distances moved would be less, the location shown is chosen.

Motion for the second link set is generally linear and

at right angles to the average angular orientation of AP. That is, it does not oscillate between minimum and maximum operating radii as does the first link set. This indicates a gear reduction type of second link set for a partial revolution only while A rotates 622 deg from A_1 to A_6 . At this stage an assumption must be made as to the anticipated rotation of angle β of the second link set. Generally, 90 deg represents a practical starting value, and this is chosen. Angular relationship between the primary links is plotted for a direct gear reduction between the primary links, Fig. 6c. For 622-deg rotation of A and 90-deg rotation of β , a 6.91:1 gear ratio is required. Values of angle β for each point are determined from the plot, Fig. 6c.

Proportions of the second link set are determined next. Fig. 6d shows a compromise location for B_0 such that the link set dimensions best match the six points with 90-deg rotation of angle β .

The two link sets are then combined as in Fig. 7 with the 6.91:1 gear ratio and a 1:1 four-bar linkage. The resultant P locus deviates 2.5 per cent or less of the total travel (from P₁ to P₆) at every point. Precision points are located at P₁, P₃, P₅, and P₆. These are arbitrary choices for the second link set and may be changed to suit design requirements. Further developments for improved accuracy

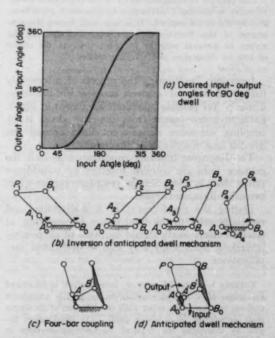


Fig. 9—Initial design steps in the development of the dwell mechanism of Example 3.

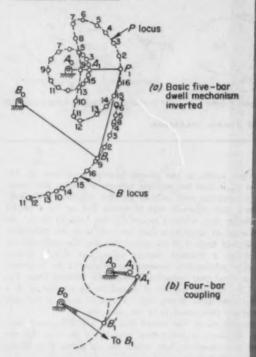


Fig. 10—Details of the two basic design elements of the dwell mechanism of Example 3.

might include other values of angle β , compensation by means of the four-bar coupler CB', noncircular gear coupling, as well as a further study of each of the outlined design phases.

This example demonstrates many of the elements of design necessary to develop a mechanism to generate a given function by the forced method. It is seen from forcing the generation of this function that preliminary analysis of the system in question may be in order, prior to the choice of link set dimensions and coupling devices.

Inversion: Inversion is the process of successively fixing the links of a given coupled five-bar loop. Three of five possible inversions are shown in Fig. 8. Each inversion comes from the one above it by coupling successive nonadjacent links around the five-bar loop in a clockwise direction.

The Examples illustrate conditions in which the primary links are coupled together by coincidence rather than by plan. Similar procedure applies when two other links are coupled.

During the development of a mechanism, and especially prior to the final choice for coupling, at least a cursory study should be made of all possible inversions. Such study may lead to overlooked simplifications.

EXAMPLE 3, DWILL MECHANISM: Inversion can be illustrated by design of a five-bar mechanism to modify continuous uniform rotation of an input shaft into rotation of an output shaft, interrupted by a 90-deg dwell. The development begins by describing the required motion characteristics in graphic form, Fig. 9a. For convenience, 45 deg of dwell are placed at the beginning of the cycle and 45 at the end. An

arbitrary smooth curve is constructed to join the 45 and 315-deg points.

At this stage the design approach must be determined. To conserve space, rather than consider the many forms of dwell mechanisms, details of a single method are described. This dwell concept can best be described by observing the motion characteristics of a single link set.

In the foregoing examples little attention is paid to the relative movement between the primary and the secondary links of a link set. This relative motion may well be assumed to change continuously, and this is often the case. Instead, let the primary and the secondary links remain fixed relative to each other as they rotate through a cycle. Under these conditions, they act as a single link. Now fix either of the links with respect to a newly defined base. The other link is also fixed with respect to the new base since the relative motion of the two links of the set is zero. It thus experiences a continuous dwell.

As a next step, let the secondary link remain fixed with respect to the primary link during only a portion of the 360-deg rotation of the primary link. When the primary link is later fixed with respect to a newly defined base, the secondary link dwells with respect to that new base during only that portion of the cycle where previously it remained fixed to the primary link. The secondary link then dwells for a finite period during each cycle.

The transitions so described, in which a previously rotating link is subsequently fixed, represent inversions of the simple mechanism. This inversion is the basis for the dwell mechanism developed here.

In Fig. 9b, primary link AaA and secondary link AP form the link set. They remain fixed with respect to each other for 90 deg in the first two diagrams, while in the last two the primary link rotates with respect to the secondary link. Note that the secondary link merely oscillates between points P_1 and P_2 while the primary link rotates 360 deg. Later, when the primary link is fixed, it can be seen that a 90-deg dwell of the secondary link results during that period of zero relative motion between the two links.

A second link set $B_0B:BP$ is then added to constrain the first set to the motion described. Its primary link oscillates between positions B_1 and B_2 and by means of its secondary link suides the oscillations of AP as described.

These five links, including initially fixed base link A_0B_0 , represent the five-bar portion of the mechanism. So far, they remain unconstrained. A coupling means is now required to force the second link set to control point P in the manner prescribed.

For this coupling, a four-bar linkage is chosen, Fig. 9c. It utilizes the continuous rotation of primary link A_0A to yield the required oscillation of primary link B_0B . Coupler link A'B' is added which causes link set $A_0A:AP$ to move as one during 90-deg rotation of its primary link A_0A .

The five-bar loop and this four-bar linkage are then combined and inverted as shown in Fig. 9b to form the complete mechanism. Note that the input was the base link and that the output was the secondary link of the first link set. The coupling now links the base link to a secondary link, thus forming the second inversion as defined in Fig. 8b. A mechanism comprised wholly of links is then anticipated, and consequently should display many of the basic advantages inherent in such mechanisms.

Initial design steps are illustrated in Fig. 10a. Dimensions of link set AoA:AP are chosen conveniently. Primary link AoA rotates through 360 deg to describe the input angle of Fig. 9a. Angle AoAP represents the output with respect to input angles of the same figure. The P locus is then developed by rotating primary link AoA and plotting values of angle AoAP obtained from the plot of Fig. 9a. The anticipated dwell period is to occur between Po and Po during which period AoA and AP are collinear, Fig. 10a.

The second link set BoB:BP is next required to force P

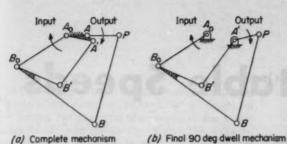
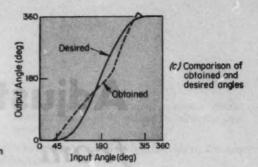


Fig. 11—Mechanism resulting from solution of Example 3 and a comparison of the predicted and the desired motions.



to follow the locus just defined. This is preserved especially for the dwell period. Values between the terminal dwell regions are merely suggested by the connecting curve of Fig. 9a.

Before link set BoB:BP is proportioned, the range of transmission angle is examined not only to serve as a design guide, but also to indicate optimum design for generation of the given function.

Consider again Fig. 9b. Transmission angle APB changes from a small to a large value during the dwell period. During the transition period, it reverts to the small value again. If the dwell period defines the transmission angle range (from minimum to maximum), the 90-deg dwell requirement approaches the 100-deg limit recognized as good design practice. An optimum condition occurs if the transmission angle is 90 deg at the midpoint of dwell with a 45-deg excursion on either side. However, care in design must be exercised to achieve an optimum. Moreover, the range of transmission angle can be broadened from 30 to 150 deg quite safely.

Inverted mechanism, Fig. 9d, has another transmission angle BoBP which must be kept within limits. Also, transmission angle A'B'Bo of the four-bar coupling should be examined.

With the two five-bar transmission angles as guides, the second link set is designed, Fig. 10a. Determination of the B locus is routine. This completes the five-bar loop.

Next, the four-bar coupling is developed to drive primary link BoB through the angular values indicated for an input pivoted at Ao. Special emphasis is placed on contacting the seven precision points 14, 15, 16, 1, 2, 3, and 4.

Completion of the system is realized by combining the five-bar loop with the four-bar linkage just developed. This combination is then inverted to form the dwell mechanism of Fig. 11a. Input is at AoBo which in the inverted form was the fixed link. Output is link AP. The mechanism is shown in position I, the midpoint of the dwell period. An appreciation for minimizing the size of the second link set can be gained by noting that both links move through large displacements and could subject the system to large dynamic forces at high angular velocities.

Note that the mechanism has three fixed pivots: Ao, A, and A'. A desirable simplification results if pivot A is eliminated and the output link is shifted to A'P. Because of the proxingity of these two pivots, this is feasible with little change in output characteristics. A 90-deg dwell is retained since P remains fixed for 90 deg.

Resulting input-output relations are superimposed over the original assumed values in Fig. 11c. Good agreement with original requirements is obtained with six of seven precision points for the dwell period attained and approximately a 3-deg deviation for the seventh. Momentary reversal occurs at about 300 deg.

A drag link12 applied at the input can be phased to provide either a dwell in the order of 180 deg or used to modify dynamic characteristics over another portion of the cycle. Such a situation results if A'B' (coaxial with the output) becomes the input link. It would be a coincidence if this move netted a desirable output. However, it is interesting to note that essentially the same dwell results with a shift in the position of maximum angular acceleration from one end of the dwell to the other.

Dwell mechanisms 12,13,14 find broad application today. An inherent advantage of this mechanism, other than simplicity of construction, is lack of backlash after extended use. Some freedom is also available in its input-output characteristics.

The basic concept presented in Example 3, namely forcing the angular relationship between two links and subsequently inverting the mechanism, is not limited to a dwell mechanism, of course. Indeed, a broad field of rotary programing is available by this method. Each method of coupling presents its own area of possibilities to further exemplify the versatility of the five-bar loop.

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Adjustable Speeds from Single-Speed Motors

Mechanical adjustable speed provides controlled ac frequency in this drive system. It permits simultaneous speed adjustment of several motors, and gives freedom to select any ac motor from the wide range of standard types available. This article on the system, and how to apply it, has been developed with the cooperation of U. S. Electrical Motors Inc., Los Angeles.

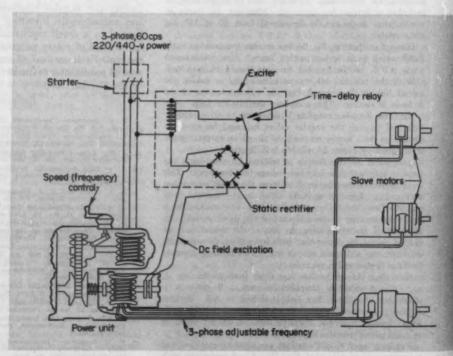


Fig. 1—Basic ac controlled and co-ordinated adjustablespeed system is built up from standard off-the-shelf hardware. Power unit converts fixed-frequency line power to adjustable-frequency output to operate motors.

SPEED control of a machine—or a battery of machines—can be effected by a variety of means, ranging from the simple to the highly sophisticated, with prices to match. The inherent speed constancy of motors plugged into utility power lines is excellent for many purposes, such as clocks, tape recorders, and a host of other applications. But it adds considerably to the cost of providing stepless speed changes for an ever-increasing variety of machines, equipment, and appliances. The design engineer's goal in such applications must be maximum simplicity and reliability coupled with minimum cost. The drive system discussed in this article represents one manufacturer's answer to this problem.

Briefly, the three types of speed-control systems

- Mechanical—consisting of belts, adjustable-pitch sheaves, clutches, pulleys, line shafts, friction rollers, and differentials.
- Electrical—consisting of specially-wound or multipole or brush-shifting motors, motor-generator sets powering dc motors, rheostats, or adjustable autotransformers with ac motors.



Fig. 2—Heart of the U. S. Electrical Motors system is the Varidyne power unit. Varidrive motor and adjustable sheave-belt combination drives the alternator (lower element) at controlled speed to give desired frequency.

 Electronic—based on thyratron power-tube circuits which convert ac to dc and use dc adjustable-speed motors.

Within these major classifications there are many combinations.

Basic System: The frequency-controlled system developed by U. S. Electrical Motors Inc. and named the Varidyne is shown in Fig. 1. It consists of a power unit, which converts standard 60-cps three-phase line power into frequencies both above and below supply frequency, plus a circuit which supplies these converted frequencies to one or more drive motors. The speed range of the basic system is 5:1 but can be extended to 10:1 or more by special components.

The power unit, Fig. 2, consists of an integral motor-belt-adjustable sheaves combination, alternator, and static exciter—all packaged to operate as a unit. Voltage is automatically regulated at start-

ing and during frequency changes.

Frequency is adjusted by controlling the speed of the power unit. Inasmuch as the speed of a standard ac motor is always directly proportional to the frequency of the current it receives, a continuous succession of stepless speed changes within the operational range is possible. The speed of the power unit can be changed manually or by remote or automatic controls.

System Advantages: This ac speed-control system has a number of inherent advantages and is easy to apply in the design of either a plant production complex or an individual machine. As a design element, it provides a degree of flexibility in the placement of drives that eliminates the need to compromise on such limiting factors as position, attitude, number, and mechanical linkage.

The inherent advantages of the frequency-controlled system include:

- Load-equalizing between all drive motors in a multimotor application.
- Co-ordinated operation of all motors in a multimotor application.
- Speed stability regardless of heating or changes in electrical resistance.
- Simplicity of an all-electrical system made up of standard components.
- 5. Insensitiveness to environment.
- Remoteness of the power unit from the drive motor or motors.

- 7. Adaptability to provide special operational features.
- 8. Protection of drive motors from overspeeds.
- 9. Quick-starting of drive motors.

In some applications one advantage may accompany another so that no distinct separation is possible. For instance, remoteness, simplicity, and environment may be interrelated, or co-ordination of motor operation may be related to load-equalizing. Consequently, a certain amount of overlapping will occur in the following explanations of some of these specific advantages.

Load-Equalizing: The inherent load-sharing feature of the frequency-controlled system makes it ideal for multimotor applications such as long conveyors. All motors in such a system, including the power unit, are expected to be properly sized for the application and load. Thus, when the power unit is accelerated, all motors receive an increasing frequency.

Even if a motor is lightly loaded during acceleration, its speed cannot exceed the speed determined by the power frequency supplied to all the motors in the system. Conversely, if a motor is connected to a high-inertia load, it does not accelerate at a slower rate than the other motors. Instead, its greater loading is felt by the power unit, which then slows to a rate of acceleration equal to that of the highly loaded motor. Thus, all motors in the system will be uniformly accelerated.

This same principle applies whether the system

is accelerating, changing speeds, or running at a constant speed. In the case of deceleration when the power frequency is decreasing, the higher-inertia motor again governs the rate of speed change. The high-inertia motor acts as an induction generator and feeds power back into the system to reduce the rate of deceleration of the other motors during the stopping period.

Co-ordination: As explained for the principle of load-equalizing, the speed of no motor in a multimotor application can exceed the speed determined by the power-unit frequency. The entire system is tied together during acceleration, speed changes, and deceleration. It is not necessary to figure the WK^2 of each driven machine as well as the WK^2 of the rotor of the driving motor, nor to insert an adjustable resistor in each slave-motor line, and then tune in their co-ordinated stop by attempting to balance all these factors. Thus, the inherent co-ordination of the system provides a practical degree of synchronization.

Co-ordination of drive motors is particularly important in a range, Fig. 3, performing a series of operations on a continuous strip of material. The material, or web, is passed through pinch rolls, around capstans, through embossers, printing presses, dryers, coaters, etc. The material may be cloth, rubber, paper, strip steel, round wire, cable, impregnated fabric, plastic, etc.

Ranges may have as many as 20 motors, all per-

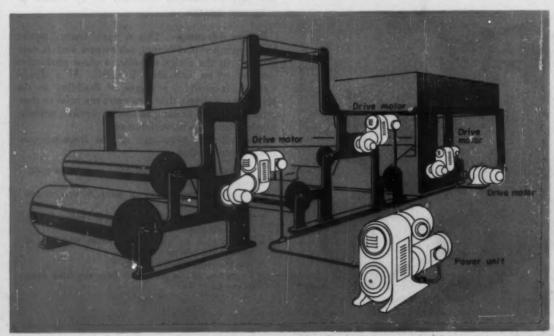
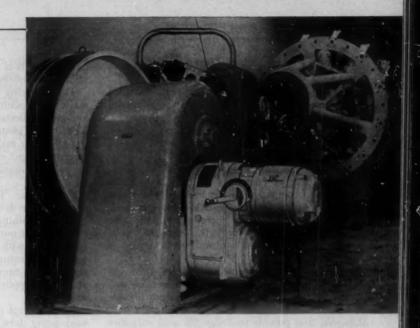


Fig. 3—A range with four drive units is supplied by a remote adjustable-frequency power unit. Three motor-belt-adjustable sheave units provide speed-trimming. The fourth drive is a double-reduction gear motor.

Co-ordinated over-all speed control for cable-stranding machine is provided by the frequency-controlled system. Used to produce multiconductor cable, this machine incorporates three drives cage drive and power unit, capstan drive, and tapinghead drive. Speeds of these individual drives can be trimmed to handle different size strands of wire.



forming work on the same piece of material. This requires adjusting the speed of each drive motor individually to maintain the proper tension, or no tension where, for instance, paper is at "wet strength."

Individual drive-speed adjustment is accomplished by replacing the standard ac motors-at those drives which require speed-trim-with an integrated motor-belt-adjustable sheaves unit. Thus, speeds at those drives can be adjusted and, once set, the over-all system control maintains the new speed relationship no matter how the system line speed is changed. Speed trimming in this manner involves a minimum of adjustment and attention. Gearmotors may also be used in conjunction with standard motors and speed-trimming units without sacrificing either synchronization or load-sharing in the system.

In many systems speed-trim is accomplished from a remote control panel by servomotors plus remote speed indicators. This type of operation can easily be automated so that the material-in-work causes changes in drive-motor speeds to maintain the process within predetermined tolerances. In such cases, tolerances may be set much closer than is feasible for manual operation of controls, and a resultant savings in material, time, rejects, and manpower is realized.

Basic to the automation of a production process is a sensing device capable of transmitting a signal -preferably in terms that reflect the degree of correction needed. The signal of the sensing device is transmitted by mechanical, pneumatic, electrical, or electronic means back to the motor speed control where it effects an increase or decrease in motor speed. Often there is a choice of sensing devices for a particular variable. Some of the more commonly used devices include dancer rolls, tensiometers, tachometers, floats, manometers, synchros, thermostats, and flow meters.

Typical production variables for which close tolerances can be maintained are: Pressure, temperature, humidity, torque, viscosity, tension, weight, position, liquid level, cutting speed, grinding speed, flow rate, surface speed, filtration rate, drying rate, machine-tool programming, conveyor speed, lineal

velocity, load level.

In multimotor systems the need for co-ordination is ordinarily met amply by the system's inherent capabilities. In applications which require absolute synchronization-for instance, where two or more motion patterns must be mingled without making contact-synchronous motors must by used instead of the usual squirrel-cage motors. Also, a position control must be added to the basic system. These modifications provide position synchronization for such applications as point-to-point transfer between conveyors and machines,

Stability: Motor speeds depend only upon ac frequency and are changed only by the alterations of frequency accomplished through the power-unit control. Since the speeds of standard ac motors are directly proportional to changes in frequency, motor speeds remain stable at any selected frequency (or speed) setting regardless of environmental conditions or differences in power, inertial factors (rotor), machine loadings, and other variables. Also, because the speed changes of the system are based on stepless speed changes in the power unit, motor

speeds can be adjusted or set with a high degree of accuracy.

Heating of the windings, length of leads, resistance components, and other unpredictable resistance changes affect only line voltage and not frequency. Therefore, these factors do not have any effect on the speeds of the ac motors in the control system.

Simplicity: Standard ac motors have simple windings and a rugged construction which make them light weight, compact, reliable, and easy to maintain. Both motor and parts can be easily replaced. Consequently, original and operating costs are low. Operationally, these motors give excellent speed regulation without warm-up, and motor torque is relatively constant.

Squirrel-cage motors are readily available and easy to work into an over-all design because numerous locations and mounting surfaces are suitable to their size-and-weight versus power requirements. Moreover, it is possible to design for total enclosure where such conditions as heat, abrasive dusts, and corrosive atmospheres would ordinarily shorten motor life, or for true explosionproof characteristics in hazardous-fume or explosive-dust atmospheres.

The simplicity of the system is further realized when the control components are considered. All control components are standard items of three-phase electrical equipment. Because fewer components are required than for dc systems, fewer items need replacement. Also, downtime occurs less fre-

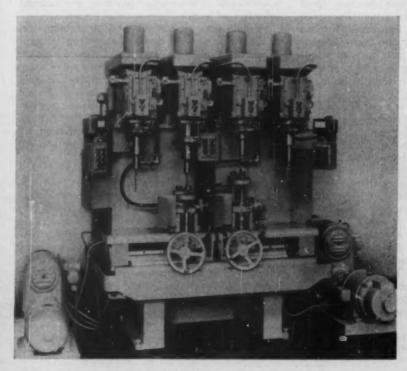
quently and is of shorter duration than a production stoppage involving more complicated systems.

Thus, placing a few simple components in a machine or plant rather than a number of bulkier and more delicate components is easily accomplished. The control center is also simplified. In addition, the ability to make the system relatively insensitive to environment eliminates any special requirements for air conditioning, filtering etc.

Remoteness: The power unit can be mounted either on the driven machine or separately. It can be located within sight of the machine and/or work-in-progress or out of sight where visual control must be replaced with remote speed indicators and possibly other instrumentation. Where the system includes speed-trim, electrical remote controls must also be supplied at each motor-belt-adjustable sheaves unit.

If the control center is located out of sight of the work being done, automatic control may be substituted for manual speed adjustment. This type of operation can be accomplished wherever the critical variable in the production process is a function of drive-motor speed, and a sensing device can be found which will transmit a signal impulse each time the variable approaches either tolerance limit.

Adaptability: The basic system can be adapted to provide such special effects as inching, jogging, creep-speeds, and threading-speeds. Soft starting of



A progressive multiplespindle machine con-trolled by the adjustable - frequency system provides two choices of spindle speeds. Each set of two squirrel-cage motors has its own power unit to eliminate resetting of adjacent spindles. Both high speeds for boring and reaming smaller holes (or softer material) and low speeds for larger holes (or harder material) are simultaneously available with this setup.

drive motors is likewise attainable either with the foregoing effects or separately. For applications which require quick stopping, dynamic braking can be achieved in combination with the other effects or separately.

Protection: Motor speeds, under frequency-control, cannot exceed the system speed determined by the power unit even if loads are suddenly removed or any electrical circuit opens. Hence, there is no need to provide each drive motor with an overspeed safety device.

Application Factors: The procedure for fitting a frequency-controlled system to a particular application is relatively simple. It is necessary only to figure the torques and speeds within the expected operating range of the equipment and then to select suitable drive motors.

Load Requirements: Because the power requirements of the motor are a function of the speed conditions, the first step is to determine the type of load. The three basic load types are:

- 1. Constant torque.
- 2. Constant power.
- 3. Variable torque.

Of these three types, constant-torque and variabletorque loads are the most common.

For a constant-torque load the requirements for greatest power will occur at top speed. Once this power requirement is determined, the power unit and three-phase squirrel-cage drive motors for the application are selected to match the expected totalconnected load and speeds. Ratings frequently used are given in Table 1.

For a constant-power load, virtually the opposite conditions govern power unit and motor selection. Here, maximum torque occurs at minimum speed, and the system which fulfills the conditions most economically within the limitations of the equipment is selected. This type of load requirement, however, is seldom encountered.

The requirements of variable-torque loads for single or multimotor systems are in every way similar to those for constant-torque loads. Consequently, these two types can be treated alike when sizing the system.

Speed Requirements: The highest and lowest driveshaft speeds normally required by the equipment are determined before selecting a control system. Providing some margin for extraordinary requirements must be weighed against considerations of economy - both original and operating costs - to avoid either overcapacity on the one hand or possibly unsafe or unsatisfactory operation on the other. It is impossible to set forth any percentage margin that would apply in all cases,

In some industrial situations, for instance, it may

be necessary to pump a liquid ingredient into a batch in a fraction of the ordinary time to correct a situation that might otherwise cause spoilage or endanger machines or personnel. Fortunately, emergency speeds most often need be little greater than ordinary operating speeds. Thus, economies can still be observed by designing speed capacities reasonably close to the normal speed range of the system.

When the required speed range has been determined, the choice of actual speeds is practically un-

Table	1-	Ratings	for	Sing	le
		Applic			

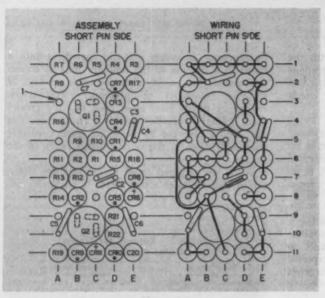
Motor I ——in 00 Power			Rating in Power Circuit- Speed
(hp)	(rpm)	(hp)	(rpm)
14	1900		3000/60
	1200	White late as	2000/40 2000/40 2000/40 2000/00
	1800		2000/46
1	1.000	16 24 24 24	3000/60
	1200	the least of the last	2000/40
116	1800	and the same	3000/60
	1800 1200 1800	The banks	3000/60 2000/40 3000/60
237	1200	The MIGHT STATE	2000/40
	1800		2000/80
1 -41 530	1200	S. PATHAGAIN	2000/40
6	1800	1.1 7% no i	2000/40 2000/40 2000/60 2000/40
7%	1200 1800 1200 1800	10	3000/60
	1200		2000/400
10	1800	15	3000/60
15	1200	205	3000/400
10	1200	12 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	2000/500
20	1800	30	3000/750
	1200	12/2	2000/500
25	1800	60	3000/750 3000/500
30	1800	50	3000/750
	1990		2000/500
10	1290 1800	60	2000/750
	1200	78	2000/500 3000/750 2000/500
50	1800		2000/100

limited. In addition to normal-speed squirrel-cage motors, gearmotors with either speed-reducing or speed-increasing ratios are available. Besides single, double, and triple-reduction gearmotors, adjustablefrequency systems often incorporate right-angle worm-gear motors.

In multimotor systems it is also possible to intermix normal-speed motors and gearmotors in the same system. The result is that proportional speeds are maintained between the units regardless of speed

changes for the entire system.

It is often desirable to adjust the speed (speed trim) of one or more motors in the same system. This is accomplished by using a self-contained motorbelt-sheaves adjustable-speed drive with or without integral gearing. Once this unit has been adjusted or trimmed, its speed remains proportional throughout the speed range for the system.



Dimensionless Assembly Drawings

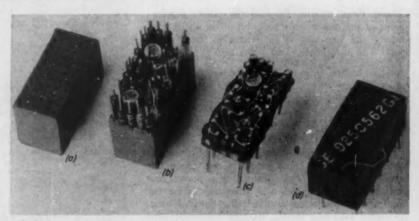
for electrical and electronic modules

J. C. RUBIN

Advance Design Engineer Defense Electronics Div. General Electric Co. Johnson City, N. Y.

Fig. 1-Part of an assembly drawing showing component and wiring schematics arranged on a grid. The comranged on a grid. The com-plete drawing also includes a view of the wiring from the long-pin side, a circuit diagram, a functional dia-gram, and a parts list. Plus sign or dot indicates end nearest viewer.

Fig. 2-Module for digitalcomputer prototype. Block, a, is an assembly fixture in-to which the components are placed, b. The bases are then secured with a plastic coating, c. After wir-ing and testing, the module is encapsulated, d.



NEW technique for dimensionless drawings has been developed for electrical and electronic modules. Circuit design and layout are presented on a single drawing, Fig. 1. No assembly dimensions are required. All components are assembled in standard fixtures, and all connections are wire-wrapped and wave-soldered on a grid fixture. The following general points can be observed for most applications:

- All component leads are positioned on a standard 0.1-in. grid, Fig. 1. This grid is defined by numbers and letters in the vertical and horizontal view-margins.
- Connections are called out directly by assembly line, or by grid-point tabulation.
- The schematic diagram, assembly views, and wiring informa-tion are all shown on a single sheet.
- 4. Each electrical component is shown on a separate line on the parts list, regardless of its frequency of occurrence. Thus, modifications or variations may easily be shown in a column at the right of the parts list. This method also simplifies field-failure reporting.

A module for a digital-computer prototype, Fig. 2, shows the simplicity of this system. The step-by-step method for fabricating the modules is shown.

The holes in the fixture, Fig. 2, are on 0.1-in. centers, and are smaller in diameter than any component lead-wire used in the assembly. The assembler inserts the electrical components into this fixture as called out on the single assembly drawing and parts list, Fig. 1.

After all the components have been inserted and visually inspected against the drawing, their bases are secured by plastic coating. Component leads are then connected by wire-wrapping and soldering. The resulting subassembly is then removed from the fixture, and excess wire is clipped. At this stage, the circuit may be visually inspected against the drawing, and tested before encapsulation.

This "3-D" technique offers the following advantages over conventional electrical-assembly methods:

- Standardization.
 High packaging density with standard or microminiature components.
 Simplified design.
 Simplified layout drafting.
 Simplified and minimized manufacturing planning.
 Simplified manufacturing planning.
 Simplified manufacturing planning.
 Simplified manufacturing planning.

This method permits the assembly of a denselypackaged electronic circuit with a minimum of drawings, planning sheets, special hardware, or complicated fixtures. The grid system also shows considerable promise for automated assembly and tests.

Nomogram + load-support factor simplify calculation of

Critical Speed of Shafts

for 7 operating conditions

WILLIAM GRIFFEL

Ordnance Engineer Picatinny Arsenal Dover, N. J.

RITICAL speed of a shaft depends on the magnitude and location of the applied load, on shaft diameter, and on the type of supporting bearings used. Although operating speed of a shaft should preferably be below its critical speed, this may not always be possible. In any case, a margin of 25 per cent is usually recommended for safe operation.

The critical speed, N_{er} , of a shaft can be found from¹

$$N_{e\tau} = \frac{K\sqrt{E} \ d^2}{\sqrt{WL^3}}$$

The nomogram shown in Fig. 1 solves this equation by means of a load-support factor K. This nomogram can be used to find the critical speed of shafts under seven different load and support conditions, Table 1.

In this method, if the shaft is rotating on antifriction bearings, it is assumed to be simply supported. If the shaft is rotating on sleeve bearings, it is assumed to be fixed-ended. The method applies to horizontal as well as vertical shafts.

Data required for determining the critical speed of a shaft are the same as those required to calculate shaft deflection. Since a shaft is often of variable diameter, and since its stiffness may be increased by a long hub, it is necessary to assume a shaft of uniform diameter and stiffness. Under certain support and load conditions, a percentage of the shaft weight, ΔW , can be added to the applied load for greater accuracy in computing critical speed. Values of ΔW are given in Table 1.

While a shaft carrying a distributed load may have an infinite number of critical speeds, the first critical speed is usually most important to a designer. The nomogram, Fig. 1, used with load-support factor K, yields this value.

Example 1: A steel shaft has diameter d=1.5 in., and length L=15 in. It carries a uniformly distributed load W=60 lb. Anti-friction-bearing supports are used.

This situation corresponds to Case 5, Table 1. Thus, K=412. Modulus of elasticity, E, of steel is 30×10^6 psi. Then, from the nomogram:

- 1. Align K = 412 with $E = 30 \times 10^6$, to intersect Index 1.
- 2. Line up the intersection on Index 1 with d = 1.5 to intersect Index 2.
- 3. Connect the point on Index 2 with W=60 to intersect Index 3.
- 4. Line up the point on Index 3 with L=8. The line intersects the $N_{\rm er}$ line at $N_{\rm er}=30{,}000$ rpm, which is the required critical speed.

Nomenclature

^{&#}x27;References are tabulated at end of article.

d = Diameter of shaft, in.

B = Modulus of elasticity, psi

K = Dimensionless load-support factor

L = Length of shaft, in.

Ner = Critical speed of shaft, rpm

W = Concentrated load on shaft, lb

w = Load per unit length, lb

ΔW = Percentage of shaft weight added to concentrated load, lb

Example 2: An aluminum shaft is cantilevered from a fixed journal bearing. It has an unsupported length L = 10 in., and diameter d = 2 in. If the critical speed $N_{er} = 4000$ rpm, what is the maximum concentrated load that the shaft can carry?

From Case 3, Table 1, K = 72. Modulus of elasticity, $E = 10 \times 10^6$ psi. Then, from the nomo-

1. Line up K = 72 with $E = 10 \times 10^6$ to intersect Index 1.

2. Connect the point on Index 1 to d = 2; mark the intersection with Index 2.

3. Align N = 4000 with L = 10, intersecting Index 3.

4. Connect the points of intersection on Index 2 and 3 to give W = 50 lb.

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- A. Vallance and V. Doughtie—Design of Machine Members, McGraw-Hill Book Co. Inc., New York, 1951, p. 198.
 Marke' Mechanical Engineers' Handbook, McGraw-Hill Book Co. Inc., New York, sixth edition, pp. 105-106.

Table 1—Values of K for Various Load Conditions

Load-Support Condition*		Load-Support Factor, K	ΔW* (per cent
Bearings simply supported, concentrated load at center	Case 1	288	49
Bearings fixed, single con- centrated load at center	Case 2	576	39
Dollar Internal	Case 3		
One end in fixed bearing, one end free, end load		72	30
One end in fixed bearing, one end simply supported, concentrated load at center	Case 4	436	0
Bearings simply supported, uniform load	Case 5	412	100
Bearings fixed, uniform load	Case 6 W=WL	927	100
One end in fixed bearing, one end free, uniform load	Case 7	134	100

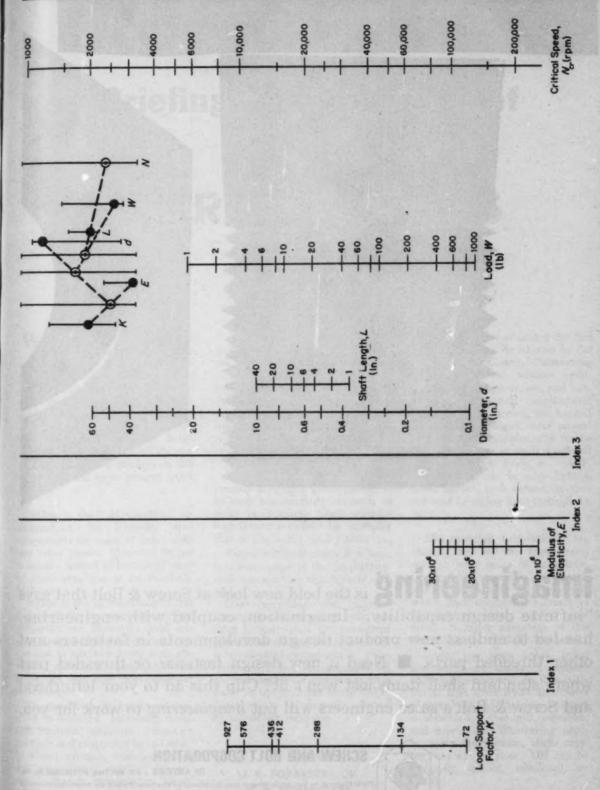
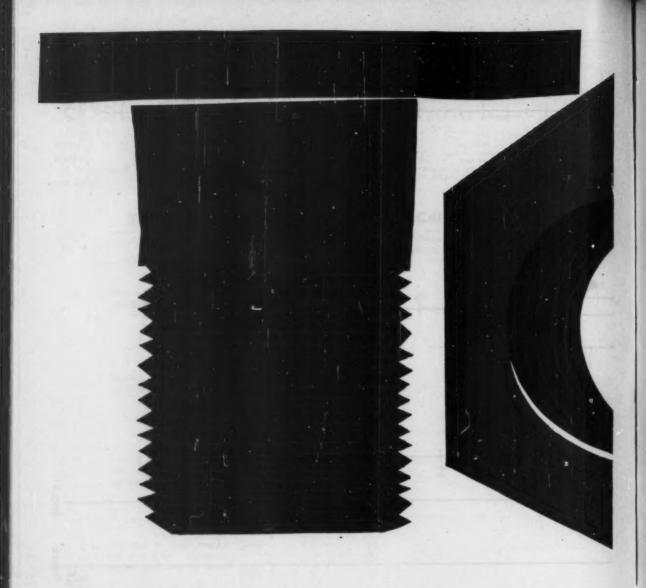


Fig. 1—Nomogram for determining critical speed of a shaft under various load conditions. Note that for Cases 5, 6, and 7, concentrated load W = wL



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Briefing the properties of

THERMOPLASTICS

WHEN materials are available in large and growing families, selection of any one member involves progressively finer screening and, eventually, a compromise of properties. These statements now apply to thermoplastics, particularly since most thermoplastics are available in many modified forms. As aids in the selection of thermoplastics, charts and remarks in this paper compare seven general types, Fig. 1.

Nylon is the "old standby." In automobiles, for instance, more components are made of nylon than any other plastic. However, its use is usually limited to functional parts of small size, due to its relatively high cost.

Nylon is one of the strongest and stiffest of the thermoplastics. Other properties are: Relatively good impact strength, low friction, high resistance to oils and fuels, high abrasion resistance, good electrical properties, and high heat-distortion resistance.

On the debit side, nylons are sensitive to moisture. Increasing moisture content improves impact strength and elongation but adversely affects strength, modulus, creep, and dimensional stability. Dimensional change amounts to about 0.020 in. per in. at 50 per cent relative humidity.

Acetal resin (polyformaldehyde) is physically more like nylon than the other thermoplastics. As an engineering material, acetal rates among the best of the thermoplastics available, but widespread use is restricted by cost. Increased use as a bearing material to eliminate the need for periodic lubrication appears assured.

Polycarbonate is among the most recently developed thermoplastics to be made commercially available. It is an exceptionally tough material with impact resistance far exceeding that of any other rigid plastic.

Polycarbonate is resistant to heat. It is also unique in that its performance does not vary significantly with load.

Like everything else, polycarbonate has shortcomings that restrict its use. It is not considered resistant to oil and fuel, particularly at elevated temperatures. Polycarbonate is not recommended for use with antifreeze solutions or with water at temperatures above 160 F. Transparency is adversely affected by ultraviolet radiation.

T. H. RISK
J. R. FORRESTER, JR.
R. P. SCHMUCKAL

Ford Motor Co.

Methacrylate was among the first thermoplastics to be adopted by the automotive industry. Outstanding characteristics are weather resistance, lustrous appearance, and suitability for optical applications. Methacrylate is among the hardest of the thermoplastics, with accompanying high modulus and tensile strength. Impact strength is reduced at temperatures down to -40 F. Methacrylate can be edge lighted, flood lighted, back lighted, or illuminated by piping light through the part.

ABS materials (acrylonitrile, butadiene, and styrene terpolymers) cover a wide range of flexibilities, from pliable to rigid. This discussion is confined to the rigid type, which itself consists of a family of plastics with widely varying properties. A major advantage of this material is its relatively low cost.

Under low stress levels, nylon and acetal are usable at substantially higher temperatures than ABS, but at high stress levels the reverse is true. ABS materials are resistant to alcohols and to animal, vegetable, and mineral oils. Weathering usually causes discoloration, slight crazing, and loss of gloss. ABS can be integrally colored, metallized, or painted.

Polyethylenes are of three general

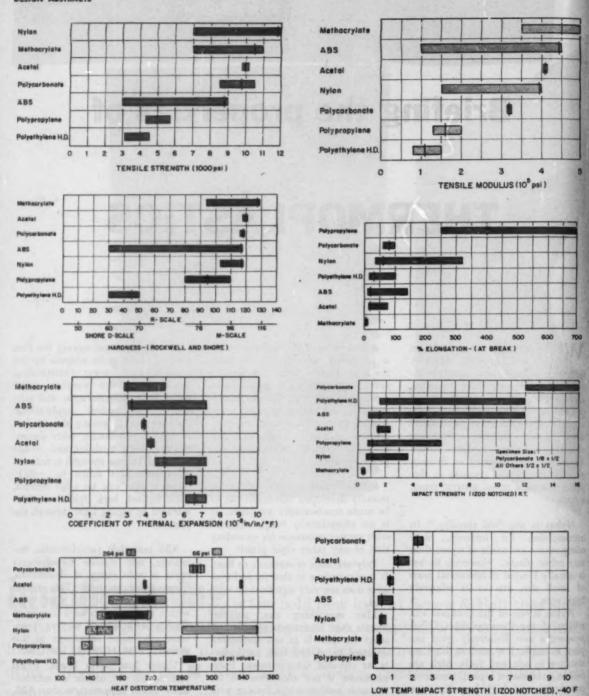


Fig. 1—Principal Properties of General-Use Thermoplastics

In each of the graphs, the plastics are arranged in descending order of excellence with respect to the physical property plotted. Each bar represents the range of values obtainable

(minimum to maximum) in commercially available types of that material. The vertical line within the range indicates a typical value for a type of that plastic in widespread use.

types: Low density, intermediate density, and high density. The third offers the highest rigidity, highest temperature resistance, and best chemical resistance.

High-density polyethylene has low

friction characteristics, and is currently under evaluation for lightload, low-speed bearing applications "lorder some extrusions... and suddenly there's an Olin consultant lighting my cigar."

"This gentleman walks in with a copy of my extrusion order, lights my cigar and starts talking aluminum, aluminum, aluminum. In short, he's telling me how Olin can save me money by making my dies, giving me better design efficiency in my extrusions. Then he shows me and welding technique and suggests a brand new market for my product! Who'd think you would ever get service like this from one of America's biggest aluminum producers? Smert people down at Olin. They know how to help a man out where he needs it meet." Inhedy thinks in aluminum better than Olin. West to talk to one of our consultants? See the Yellow Pages for our local Sales Office.



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the 87,000 Series

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Model to Torque

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to obviate the need for periodic lubrication. Due to mold shrinkage characteristics, large flat surfaces in products are hard to make.

Polypropylene resembles highdensity polyethylene in appearance. A unique property of polypropylene is its resilience and high stretch characteristics. Elongations of 400 per cent at break are not uncommon. Its flex life is exceedingly good. This combination of properties enables polypropylene to be used as a hinge.

Polypropylene is load sensitive, and its heat distortion temperature drops drastically at high stress levels.

SAE Paper No. 381A, "Improved Func-tion and Reduced Cost Through Well Engi-neered Plastic Components," presented at the Summer Meeting, St. Louis, June, 1961, 13 pp.

materials

Tensile Strength and Hardness Related for Titanium Alloys

Charles F. Hickey Jr., Watertown Arsenal Laboratories, Watertown, Mass.

Investigation to find possible correlation between tensile strength and hardness for titanium alloys.

Tensile and hardness properties are determined as a function of testing temperature, heat treatment, and section size of material. Findings established a correlation between tensile strength and hardness for stable alpha-beta alloys, but not for metastable alpha-beta alloys. In addition, a hardness correlation is established between Vickers and Rockwell C readings for the stable alphabeta alloys.

ASTM Preprint No. 87, "Tensile Strength-Hardness Correlation For Ti-tanium Alloys," presented at the Sixty-fourth Annual Meeting, June, 1961, 9 pp. Preprint price 30 cents.

Ceramic Materials for **High Temperature Applications**

W. E. Blodgett, R. B. Grekila, and H. D. Root, Westinghouse Electric Corp., Pittsburgh, Pa.

A concept whereby high-tempereture problems are minimized by the composition and microstructure of a novel body system.

This concept permits the use of

properties of ceramic materials advantageous in solid-propellant rocket nozzle applications. A "filler" material is bonded by an extremely small quantity of an inorganic polymer. The formulation of the combination is such that, for short-time applications, the properties of the filler are predominant.

The filler can be chosen from among the refractory oxides, carbides, and nitrides of metals whose oxides are amphoteric or slightly acid. The filler is chosen on the basis of chemical stability, melting point, thermal conductivity, strength at temperature, thermal expansion,

and specific heat.

ARS Paper No. 1686-61, "Ceramic Materials for High Temperature Aerospace Applications," presented at the Structures, Materials, and Design Conference, Palm Springs, Calif., April, 1961, 14 pp.

Fracture of Brass in Impact **At Elevated Temperatures**

A. R. Bailey, Imperial College of Science and Technology, London, Eng-

Reports of impact tests from atmospheric temperature to 800 C.

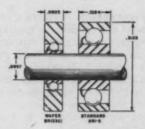
Pure alpha-brass in the cast or wrought condition did not fracture. Binary beta-brass as well as more complex alloys, in the cast condition, developed range of intercrystalline brittleness starting at approximately 200 C and ending when the structure became disordered.

Heat treatment at elevated temperatures, followed by waterquenching, did not materially alter the fracture characteristics, except with high-tensile alloys containing iron and aluminum. The behavior of simple alloys in the wrought condition appears to be little different from that of cast material. However, complex beta brass containing iron and aluminum was toughened by hot working, although there was still some tendency to intercrystalline cracking at elevated temperatures.

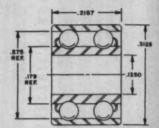
When alpha-beta alloys were quenched to give an all-beta structure, they were more prone to intercrystalline cracking, and alloys containing aluminum became distinctly brittle at room temperature. Beta-gamma alloys of all kinds were more brittle than beta alloys, the

No. 2

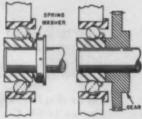
ideas you can use in working with bearings



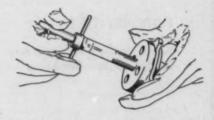
Extra-thin "wafer" bearings are ideal for use in synchros, servos, small motors, potentiometers and gear trains which require the narrowest possible bearings for any given shaft and housing diameter. The space saved by the bearings allows a shorter overall motor length; or allows more iron and copper to be added to rotors and stators without increasing overall length. A line of narrow, single-shield bearings is also available for these applications.



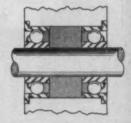
Double row bearings offer a relatively simple and economical solution to a problem found in some applications where single bearings cannot provide sufficient stability under radial loading. They provide double row stability yet can be conveniently assembled as single units. Applications include those involving cam followers, pulleys and potentiometer spindle assembles where shaft runout is not tight. Double row bearings are available from NHBB in plain, flanged or shielded construction.



When designing servomechanism gearing for minimum backlash, the bearings should be preloaded slightly at assembly in order to remove all radial play and establish positive ballraceway-ball contact. Two ways preloading can be accomplished are by using a spring washer against the inner race of a bearing; or by assembling a collar or gear directly against the bearing. When the design practudes preloading, a low radial play range such as .0002" to .0004"



The most serious type of mechanical damage to precision ball bearings can occur when the bearings are being mounted on shafts or into housings. Pressure transmitted through the balls and raceways can produce permanent dents, or Brinell marks in the raceways which greatly increase bearing torque and vibration. To reduce the possibility of such damage, avoid interference fits and use special bearing mounting tools.



Here is an idea for lubricating the output shaft bearings on gear heads which will contribute toward longer bearing life: place some grease in the space between the two bearings. The grease will act as a lubricant reservoir and the oil in the grease will bleed into the bearings over a period of time. One of the greases which has a relatively high "bleedout" rate is recommended.



should be specified.

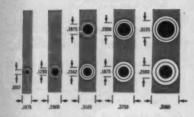
150-page Design and Purchasing Manual in the most comprehensive treatise on miniature and instrument ball bearings ever pehished. Qualified design and specifications engineers, and procursment specialists, are vectorage for a cans:

TYPICAL SPECIFICATIONS OF NHBB WAFER BEARINGS (not presently cataloged)					
BORE	O.D.	WIDTH	WAFER	RADIUS	RATING
.0937	.2500	.0625	SR133C2	.003	21
.0937	.3125	.0625	5R133C1	.005	21
.1250	.5000	.1094	SR166C8	.008	82
.1250	.4250	.0937	SR144C15	.005	36
.1250	.3750	.0937	SR144C3	.005	36
.1250	.4250	.1094	SR2-5C11	.006	66
.1250	.4375	.1094	SR2-5C5	.006	66
.1250	.5000	.1094	SR2-5C7	.006	66
.1250	.4100	.1094	SR2-5C10	.006	66
.1875	.4100	.1094	SR156C9	.005	35
.1875	.5000	.1094	SR166C6	.008	82
.1875	.4375	.1094	SR156C8	.003	35
.2500	.5000	.1094	SR168C6	.008	44

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more shaft per housing



These New Hampshire miniature instrument bearings have extra-large bores and permit you to increase shaft diameters without increasing bearing O.D. — to add strength yet keep center distances at a minimum. See the selection of shaft sizes available for given housing sizes:

BORE	O.D.	WIDTH	BEARING NUMBER	RATING
.0937	.1875	.0625	SR133	21
.1250	.2500	.0937	SR144	36
.1562 .1875	.3125	.1094	SR155 SR156	35 35
.1875	.3750	.1250 .1250	SR166 SR168	82 44
.2500	.5000	.1250	SR188 SR1810	120

Also available flanged or double shielded or with inner rings extended or with any combination of the three. Precision standard is ABEC Class 7. Material is 440C stainless steel.

NEW HAMPSHIRE BALL BEARINGS, INC. PETERBOROUGH, N. H. degree of brittleness increasing as the proportion of gamma increased.

Institute of Metals Paper No. 2069, "The Fracture Characteristics of Brass in Impact at Atmospheric and Elevated Temperatures," Journal of the Institute of Metals, Vol. 89, 1960-61, pp. 339 to 342.

Methods of Bonding Fluorocarbon Plastics

Marjorie C. St. Cyr, Materials Research Section, Plastics and Packaging Laboratory, Picatinny Arsenal, Dover, N. I.

Properties and methods of bonding various materials derived from five basic fluorocarbons.

Information is presented in four general areas: Availability and properties, methods for bonding sintered fluorocarbons, methods for bonding melt-processible fluorocarbons, and miscellaneous specialty products.

The technology basic to the identification and description of the various plastics is given briefly. Commercial suppliers are identified. Included are instances illustrating the practical applications of the techniques.

Plastec Report 6 OTS PB 171037, "Methods of Bonding Fluorocarbon Plastics to Structural Materials," 22 pp.

Selection of Materials For Noise Control

Karl Bennung Jr., Chemical Coatings & Engineering Co. Inc., Media, Pa.

Engineering approaches to noise control, and evaluation of insulating material, particularly leaded plastics.

Two engineering approaches to effective control are reduction of sound at the source and reduction of transmission through air, by means of enclosures around the sound source.

Effectiveness of a sound-absorbing material depends on the amount of energy it can convert to heat. This is related to the surface density (lb/sq ft/in.) of the material and to its internal physical properties. Lead, with a high density and "limp" character, is an excellent example of an efficient acoustical material.

Plastics and rubbers can be designed to have high energy-absorbing properties, but the physics of the



October 12, 1961

725 Custer Ave., Evanston, III. Circle 313 on Page 19



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dissipation of sound energy within these materials is not fully explored. Plastics have the disadvantage of a high-material cost and relatively low surface density. The incorporation of lead increases the surface density and reduces the cost.

Present leaded plastics will probably find their main applications where other properties, like adhesive strength, are also of benefit. Some formulations can be sprayed or used as caulks or troweling compounds.

Paper entitled, "Leaded Plastics in Noise Control," presented at the 33rd Annual Meeting of the Lead Industries Association, Chicago, May, 1961, 4 pp.

bearings

Externally Pressurized Step Journal Bearings

Clarence R. Adams and Edward M. Shoemaker, research engineers, Aero-Space Div., and Juraj Dworski, research engineer, Industrial Products Div., Boving Co., Seattle, Wash.

Practicability of externally pressurized step journal bearings.

An experimental program suggests the following design parameters:

- Step height should be 0.0003 to 0.0010 in., preferably 0.0005 in. or less.
- Step radial clearance should be 0.0004 to 0.0008 in.
- A built-in eccentricity ratio between 0.4 and 0.7 should be used.
- Step widths should be 0.020 in. or more to eliminate the need for extremely careful shaft positioning.
- Flow path length to diameter ratio should be between 0.7 and 1.0.

Simplicity of design of externally pressurized step journal bearings makes precision production economical. Step bearings can be made from any materials which can be turned, ground, or lapped. They also can be made by plating to form the steps, by chemical milling to form the recess, and by casting the steps into a housing.

Stability of the step bearing under static and dynamic conditions has been very satisfactory. In step bearings the rate of energy absorption is small because of the small contact area. The gradual absorption of energy is a fail-safe feature of these bearings.

The basic step journal bearing is limited to use in applications



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Actually, everything about Bulletin 709 motor starters is new—except the famous A-B simple solenoid principle of operation. The magnet, the contacts, the coil, the overload relays all have been redesigned and vastly improved. There's an entire new line of enclosures, too, into which Brooks Stevens has designed a family likeness and an "eye appeal" that is an added value to all buyers of control, especially where the control is resold.

Let us give you some other important facts about these new starters, which include reversing starters, multi-speed starters, combination starters, etc. Please write for Publication 6100: Allen-Bradley Co., 1316 South Second Street, Milwaukee 4, Wisconsin.

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In the enclosed reversing switch, a two-unit or three-unit block-type overload relay is mounted below the contactors. The mechanical interlocks are new and so simple in design, they just can't fail to give you dependable service. For more details please write to: Allen-Bradley Co., 1316 South Second Street Milwaukee 4, Wisconsin.



Bulletin 705 Size 2 reversing starter in Nema Type 1 enclosure. Ratings to 100 hp, 220 v; 200 hp, 440-550 v.



MOST ADVANCED CONTACTORS

Though greatly reduced in size, each rating of this new line of reversing switches has a tremendous reverse switching capacity. The new and patented high efficiency magnet is cushioned to reduce shock and wear. The new molded coil is impervious to the most corrosive atmospheres. The new precision hot molded arc hood greatly increases the interrupting capacity and confines the arc. The new weld-resistant cadmium oxide silver contacts seat square—no more sliding motion that causes wear.



NEW, POSITIVE MECHANICAL INTERLOCK

The simplicity and ruggedness of the new cam-type interlocks assure continuous reliability—they're good for the life of the reversing starter. The interlock does not have to be disturbed or adjusted after changing either contacts or coil. It is located between the contactors—out of the way—where careless wiring cannot interfere with the positive and consistent operation of the interlock.



NEW, BLOCK-TYPE OVERLOAD RELAYS

The new A-B trip-free and tamperproof overload relays—either hand or automatic reset—have also been completely redesigned. But the time-proven "solder ratchet" principle, which assures permanent accuracy and reliability regardless of atmospheric conditions—has been retained. The block-type relays are furnished as either two unit or three unit, both having identical mounting dimensions. When used on special control panels, this new design eliminates the need for a separate terminal block. An indicating device is provided on each relay to show when it has been tripped.

18-61-RM

where the load is light or high supply pressures are available. Applications which require a minimum turbine torque are ideally suited to step journal bearings. Applications in which momentary contact may occur between rotating and nonrotating surfaces can also benefit from the use of step bearings.

ASME Paper No. 61-LUBS-8, "Extremely Pressurized Step Journal Bearings," presented at the Lubrication Symposium, Miami, Fla., May, 1961, 88 pp.

techniques

Theory of Design

C. F. Cameron, D. D. Lingelbach, and C. C. Freeny, Oklahoma State University, Stillwater, Okla.

Discussion and examples to introduce a method of working design and specification problems efficiently and logically.

This introduction to a design theory offers a method of handling many presently indeterminate design problems. Important aspects of this theory are:

- A symbolic definition of a system is given in terms of parameters and describing relationships.
- 2 Given a set of parameters which are of interest, enough parameters are given to allow the minimum abstract system to be formed.
- A systematic technique is provided for applying a set of specifications to a system in order to check general compatibility.
- 4. A geometrical and point-space abstraction of a system enables the designer to get a feel for what the actual device can do in general.

Speech No. 29, "Theory of Design," presented at the Ninth National Conference on Electromagnetic Relays, Stillwater, Okla., April, 1961, 16 pp.

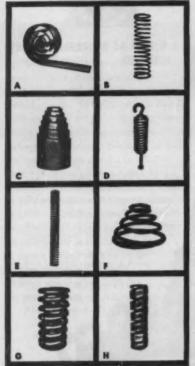
Computer Simulation of Verbal Learning Behavior

E. A. Feigenbaum, University of California, Berkeley, Calif. and Rand Corp., Santa Monica, Calif.

Simulation of elementary human symbolic learning processes.

An information-processing model of elementary human symbolic learning is given a precise statement as a computer program, called Elementary Perceiver and Memorizer (EPAM). The program simulates





A. flat S. helical C. volute D. extension S. helical F. cone O. helical, triple-coil H. rectangular section

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Circle 317 on Page 19

DESIGN ABSTRACTS

the behavior of subjects in experiments involving rote learning. A discrimination net which grows is the basis of EPAM's associative memory.

Fundamental information processes include processes for discrimination, discrimination learning, memorization, association using cues, and response retrieval with cues. Many well-known phenomena of rote learning are to be found in EPAM's experimental behavior, including some rather complex forgetting phenomena.

WICC Paper No. 3.2, "The Simulation of Verbal Learning Behavior," presented at the Western Joint Computer Conference, Los Angeles, Calif., May, 1961, 12 pp.

Digital Numerical Machine Tool Controls

N. L. Caban, Westinghouse Electric Corp., East Pittsburgh, Pa.

Characteristics of digital point-topoint positioning system which is completely static.

All logic is performed using the NOR circuit as a basic building block. Modules perform specific functions such as counting, decoding, special logic functions, and general logic. Interconnection between modules is accomplished using wire wrap.

The system may be programmed from punched tape or selector switches. "Word address" programming is used. All dimensions are programmed from a common reference which can physically be located at any point in the machine trav-

Accuracies for this type of system are quoted in terms of a specified accuracy band rather than the familiar terminology of plus or minus so many thousandths of an inch. The specified accuracy band is defined as the space between two specific pulses on either side of the target position. These could be consecutive pulses or, in some cases, may be spaced two or more pulses apart. On either side of the specified accuracy band, sufficient voltage is supplied to drive the machine and overcome static friction. Within the specified accuracy band, armature voltage is removed and the machine member is free to stop anywhere

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Circle 320 on Page 19

DESIGN ABSTRACTS

tem, it is possible to program a move of just one band width.

A reference can be established anywhere in the travel of the machine by moving the members to the desired zero point and pressing a button which resets the feedback counter. Since the system is absolute, all commands will then be referenced from this point. Programming for minus dimensions may be provided.

AIEE Conference Paper No. CP 61-628, "Digital Numerical Machine Tool Controls," presented at the AIEE North Eastern District Meeting, Hartford, Conn., May, 1961, 5 pp.

Computer Simulation of Human Mental Processes

Herbert A. Simon, Rand Corp., Santa Monica, Calif., and Carnegie Institute of Technology, Pittsburgh, Pa.

Developments, over the past decade, in the use of computers to construct and test nonnumerical explanations for human thinking and learning.

Such programs, which are beginning to be validated by behavioral evidence, are providing embryonic theories for these phenomena in terms of underlying information processes.

Kinds of simulation include:

- 1. Abstract simulation of adaptive, goalseeking, learning mechanisms,
- Simulation of the sensory-perceptual processes by which humans recognize visual and aural patterns and symbols.
- Simulation of the self-organizing capabilities of neural nets.
- Simulation of the symbol-manipulating or information processes employed in learning by rote, in attaining concepts, and in solving problems.

WJCC Paper No. 3.1, "Modeling Human Mental Processes," presented at the Western Joint Computer Conference, Los Angeles, May, 1961, 9 pp.

mechanical

Design of Elastic-Plastic Rectangular Pressure Tubing

R. D. Gauthier, Dow Chemical Co., Denver, Colo., and E. E. Weibel, professor, Dept. of Mechanical Engineering, University of Colorado, Boulder, Colo.

Failure analysis for a tube of per-

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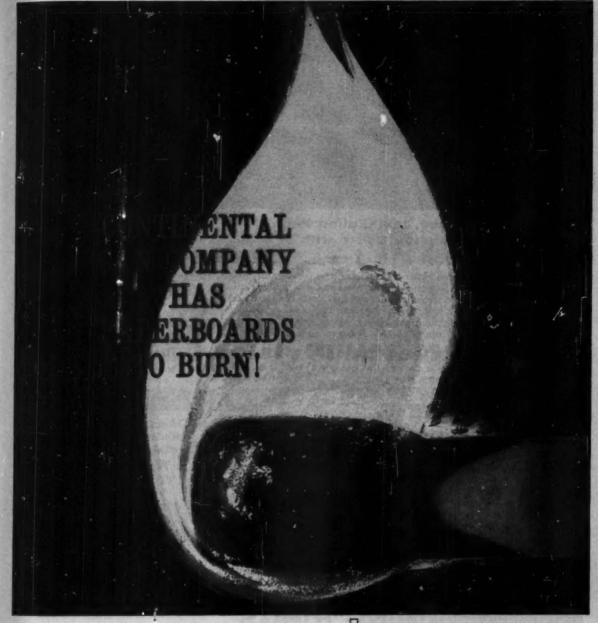
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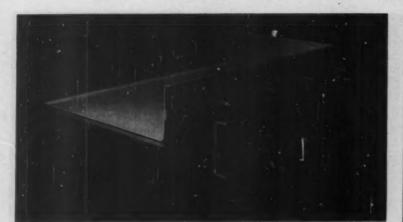
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fectly elastic-plastic material, and derivation of a formula from which the limit load can be computed directly.

A procedure is developed for determining, by the area-moment method, the wall deflection at any load, from a bending-moment diagram modified to account for reduced rigidity.

Failure of a ductile tube does not occur with incipient yielding. The limit load for a given tube is the pressure at which the strength of the tube, both elastic and plastic, has been reached and the system becomes unstable.

ASME Paper No. 61-APMW-8, "Elastic Plastic Design of Rectangular Pressure Tubing," Presented at the West Coast Conference of the Applied Mechanics Div., Seattle, Wash., August, 1961, 6 pp.

Frequencies of Vibrations of Fixed-Ended Sandwich Beams

M. E. Raville, professor and head, and En-Shiuh Ueng and Ming-Min Lei, graduate research assistants, Dept. of Applied Mechanics, Kansas State University, Manhattan, Kan.

Determination of the natural frequencies of vibration of fixed-fixed sandwich beams, analyzed by the energy method.

Analysis is carried out with the following assumptions:

- Facings of the sandwich are homogeneous, isotropic, and elastic thin plates of equal or unequal thickness.
- The core consists of an elastic, orthotropic continuum whose load-carrying capacity in the plane of the sandwich is negligible.
- The modulus of elasticity of the core, E_e, in the direction perpendicular to the facings, is infinite.
- 4. Perfect continuity exists at interfaces.

It is concluded that the theoretical analysis is sufficiently rigorous to predict quite accurately the frequencies of vibration of fixed-ended sandwich beams. For the range of frequencies considered—0 to 2000 cps—the assumptions that E_c is infinite and that the effect of rotatory inertia is negligible appear to be justified. Undoubtedly, as higher frequencies are considered, a more accurate analysis would ultimately be found necessary.

ASME Paper No. 61-APMW-2, "National Frequencies of Vibration of Fixed-

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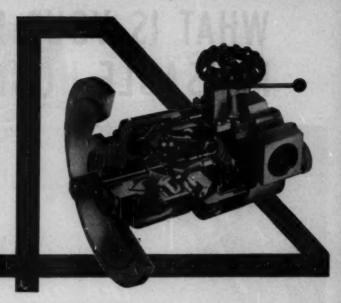
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For complete information, write for Catalog 201. Fixed Sandwich Beams," presented at the West Coast Conference of the Applica Mechanics Div., Seattle, Wash., August, 1961, 5 pp.

Variety of Motions Generated by Mechanisms

Ferdinand Freudenstein, professor and chairman, Dept. of Mechanical Engineering, Columbia University, New York, N. Y.

Nature of the curves which can be generated by points on mechanisms.

The analysis proceeds in two steps. The first concerns plane mechanisms with turning pairs; the second, mechanisms in general.

One goal is the possibility of designing a positive, mechanical transmission operating as a single-degree-of-freedom mechanism at a constant speed ratio numerically equal to an irrational number, such as the square root of two. Theoretically exact motions are investigated because of their bearing on the inherent limitations of mechanical motions.

ASME Paper No. 61-SA-3, "On the Variety of Motions Generated by Mechanisms," presented at the Summer Annual Meeting, Los Angeles, June, 1961, 4 pp.

hydraulic

Pump Characteristics and Effects of Specific Speeds On Hydraulic Transients

Benjamin Donsky, engineer, Bureau of Reclamation, U. S. Dept. of the Interior, Denver, Colo.

Complete characteristics of pumps of specific speeds 1800, 7600, and 13,500 (gpm units) in the flow ratio-head ratio co-ordinate system.

The method of developing these complete pump characteristics from test data is described. The three complete pump characteristics are compared, and the effect of specific speed on hydraulic transients caused by power failure or pump shutoff is presented.

The pump characteristics are presented in dimensionless ratios of speed α , torque β , head h_P , and flow ϵ . This allows the use of the characteristics for a pump of any initial operating condition providing the specific speeds are approximately the same. The rated point or best efficiency point of operation is that



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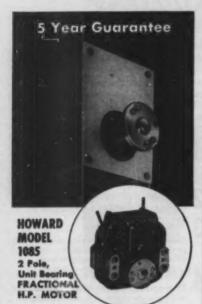
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Circle 328 on Page 19

DESIGN ABSTRACTS

a: which all ratios are usually equal to one. All of the complete characteristics include the zones of pump operation, turbine operation, and energy dissipation. Energy dissipation zones are zones in which the efficiency ratios are negative and no useful energy is being supplied to the water by the impeller or to the impeller by the water.

ASME Paper No. 61-Hyd-3, "Complete Pump Characteristics and the Effects of Specific Speeds on Hydraulic Transients," presented at ASME-EIC Hydraulic Conference, Montreal, Canada, May, 1961, 12 pp.

processes

Methods of Evaluating Sonic Energy Cleaning

T. J. Bulat, manager, Sonic Energy Engineering, Pioneer-Central Div., Bendix Corp., Davenport, Iowa.

Summary of known and prospective methods of evaluating sonic-energy cleaning.

Evaluation methods for sonic cleaning can be divided into two basic categories: Those based on acoustical parameters or direct physical activity in the insonated bath, and those based on the cleaning action of the unit.

Physical methods include: Acoustical power, chemical activity, electrolytic activity, metal erosion, efficiency measurements (three types), and degassing. Methods based on actual cleaning results include: Performance tests, visual inspection, gravimetric tests, chemical tests, radioactive tracer test, wettability tests, and surface-contamination test.

WESCON Paper No. 37/2, "Evaluating Sonic Energy Cleaning," presented at the 1961 Western Electronic Show and Convention, San Francisco, August, 1961, 6 pp.

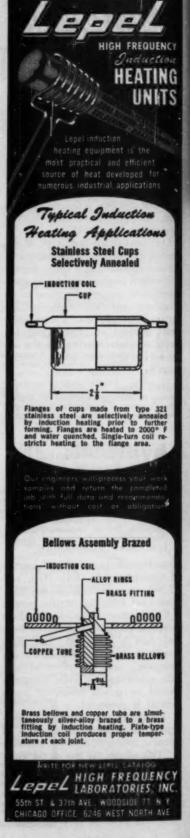
Science of Adhesive Joints

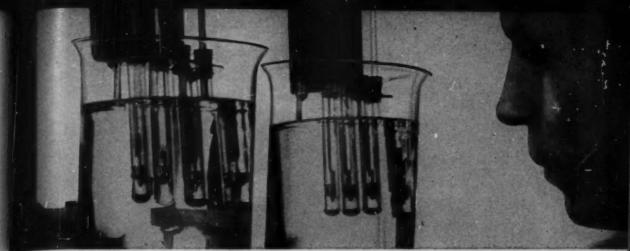
J. J. Bikerman, Massachusetts Institute of Technology, Cambridge, Mass.

Causes of failure in adhesive joints.

Mechanical rupture of an adhesive joint rarely proceeds along the adherend-adhesive interface. The absence of interfacial failure is, in many instances, explained by the absence of interface.

When a joint seems to "fail in





Dropping point test shows how greases react to heat. Beaker fluid has been heated to 390°F. All greases tested except Darina (second tube from left) have passed from solid to liquid state.

BULLETIN:

Shell reveals the remarkable new component in Darina Grease that helps it save up to 35% on grease and labor costs

Darina® Grease is made with Microgel*, the new thickening agent developed by Shell Research.

Darina lubricates effectively at temperatures 100° hotter than most conventional soap base greases can withstand.

Read how this new multi-purpose industrial grease can help solve your lubricating problems and even save you up to 35% on grease and labor costs.

There is no soap in Darina Grease.

No scap to melt away—wash away—or dissolve away.

Instead of soap, Darina uses Microgel – a grease component developed by Shell Research.

What Microgel does

Because of Microgel, Darina has no melting point. It won't run out of gears or bearings.

Compared with most conventional soap-base greases, Darina provides significantly greater protection under adverse service conditions.

Mix water into Darina and the

grease does not soften. It shrugs off water-won't emulsify.

Resists heat

Darina will withstand operating temperatures 100° hotter than most conventional multi-purpose greases. It cuts leakage and reduces the need for special high-temperature greases.

Also, Darina resists slumping, thus forming a more effective seal against foreign matter.

Saves money

Shell Darina can reduce maintenance expenses while it protects your machin-

ery. Savings of up to 35% on grease and labor are quite possible.

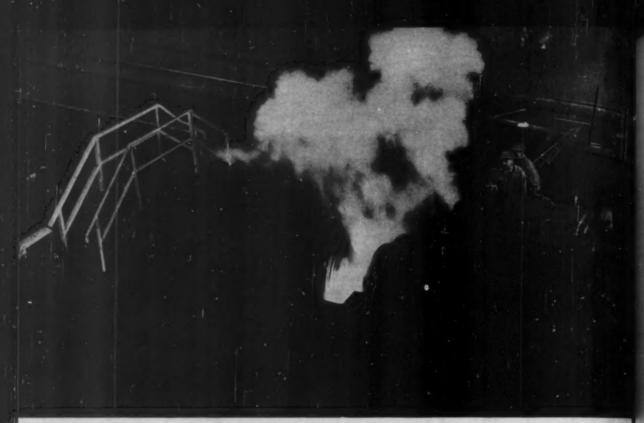
In some cases lubrication intervals have been extended to double what they were before. Less grease is consumed and less time consumed applying it.

For details, see your Shell Representative. Or write: Shell Oil Company, 50 West 50th Street, New York 20, New York.

*Registered Trademark



A BULLETIN FROM SHELL -where 1,997 scientists are helping to provide better products for industry



START: Heated billet is centered between dies of the Slick Mill.



15 SECONDS
Upset-forging starts.



30 SECONDS Rolling cycle starts.



40 SECONDS
Forging is completed.



55 SECONDSForging is removed from mill.

One minute...one circular forging

That's all the time it takes to convert a heated billet (100 to 2,000 lb) into a contoured forging on Bethlehem's unique Slick Mill.

But fast operation is only one reason why Bethlehem's Slick Mill turns out a top-quality forging at a price that's hard to match.

Ask us, or our nearest sales office, about the quick die changes, which make it possible—and economical —to set up production runs as small as 25 or 50 pieces. Ask about the low die charges which are made possible by the brief contact between die and work. Ask about the light-weight sections this mill can produce, without sacrificing strength.

We'd also like to tell you about the excellent grain flow, machinability, and soundness of every Bethlehem circular forging.

Ask. You'll like the money-saving answers.



BETHLEHEM STEEL COMPANY, Bethlehem, Pa. Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL



adhesion," often a weak boundary layer is present. There are seven classes of weak boundary layers, the most important of which is caused by poor wetting.

When an adhesive film breaks, the breaking stress of the joint is related to the inherent strength of the adhesive. But usually, breaking stress is different from adhesive strength because of stress concentrations occurring in systems of several components, because of shrinkage stresses, and because the weakest spot in an adhesive film, as a rule, is different from that in a bulk sample of adhesive.

Older theories of adhesive joints are incorrect because they assume that adhesion is a surface phenom-

Paper entitled, "Science of Adhesive Joints," presented at the Symposium on Adhesion and Cohesion, General Motors Research Laboratories, Detroit, July, 1961.

electrical

Electronic Applications of Industrial Design Technique

Donald L. McFarland, president, Latham Tyler Jensen Inc., Long Beach, Calif.

How relatively new fields, such as electronics, can benefit from early use of industrial-design techniques.

Techniques commonplace to consumer products will be more and more important as competition grows and differences between products become less distinct. The greatest weakness in electronics is the step from the laboratory circuitry to the final product.

Here are check lists to evaluate a product design:

- 1. Is the product heavier than necessary by a duplication of structure or use of heavier metal than required?
- 2. Are parts or components which require adjustments or service accessible without dismantling the entire pack-
- 3. Are the controls grouped in a logical manner rather than in a manner convenient for the factory?
- 4. Are control dials and legends easy to read under any reasonable lighting conditions and from any normal operating angle?
- 5. Are only the necessary controls placed prominently, with secondary controls grouped elsewhere?











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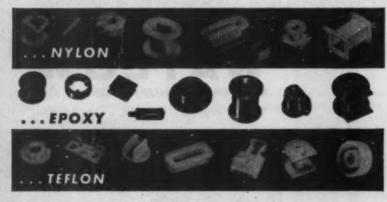
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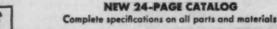
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- 6. Can control functions be combined, reducing the total number?
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- 8. Is portability convenient if required?
- 9. Are the materials, shapes, and finishes of the cabinet designed to facilitate
- 10. Is the general appearance one which denotes accuracy, reliability, and durability?
- 11. Does the product have a character which reflects its manufacturer's image-or does it look just like most of its competition?

WESCON Paper No. 35/3, "Optimized Use of Industrial Design Technique," pre-sented at the 1961 Western Electronic Show and Convention, San Francisco, August, 1961, 7 pp.

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AIEE—American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., papers 50 cents to members, one dollar to nonmembers.

ARS-American Rocket Society, 500 Fifth Ave., New York 36, N. Y.

ASME-American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York 17, N. Y., papers 50 cents to members, one dollar to

ASTM-American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

GM Engineering Journal, Public Relations Staff, GM Technical Center, P. O. Box 177, North End Station, Detroit 2, Mich.

Institute of Metals, 17 Belgrave Square, London S.W. 1, England.

Lead—Lead Industries Assoc., 60 East 42nd St., New York 17, N. Y.

Ninth National Conference on Electro-magnetic Relays, School of Electrical En-gineering, Oklahoma State University, Stillwater, Okla.

Plastec Report No. 6, available from ASTIA Document Service Center, Arling-ton Hall Station, Arlington 12, Va.

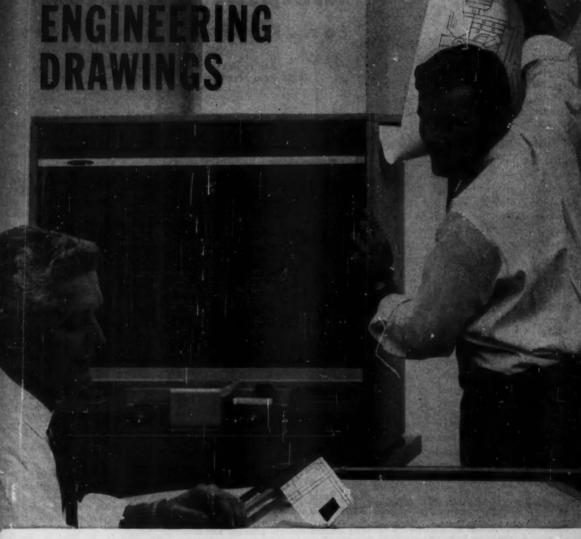
SAE—Society of Automotive Engineers, 485 Lexington Ave., New York 17, N. Y.; papers 50 cents to members, 75 cents to

Symposium on Adhesion and Cohesion, General Motors Research Laboratories, Warren, Mich.

WESCON-Western Electronic Show and Convention, Convention Record, Part 4, \$1.80 to IRE members, \$6.00 to nonmem-bers, available from Institute of Ra.lio Engineers, 1 East 79th St., New York 21, N. Y.

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Helpful Literature for Design Engineers

For copies of any literature listed, circle item Number on Yellow Card—page 19

Hose Connectors

Describes stock flexible-metal hose connectors which meet vibration, expansion, and misalignment conditions. Also includes a section on stock fittings, charts showing specifications and working-pressure correction factors, and a section on proper installation and use. Bulletin 26, 4 pages. Atlantic Metal Hose Co. Inc., 308 Dyckman St., New York 34, N. Y.

Circle 601 on Page 19

Precision Instruments

Contains new-product data on commercial meters, delay lines, off-the-shelf servo motors, precision potentiometers, trimming potentiometers, and special products such as motion transducers. "Helinews," 8 pp. Helipot Div., Beckman Instruments Inc., 2500 Fullerton Rd., Fullerton, Calif.

Circle 602 on Page 19

Multiple Switches

Provides data on both nonilluminated and illuminated types in which buttons light up to indicate position. Gives information on combinations available, and details ganged assemblies and special features. Includes information on new pushpush switch, and detailed checklist. Catalog S-306, 12 pages. Switchcraft Inc., 5555 N. Elston Ave., Chicago 30, Ill.

Circle 603 on Page 19

Metal-Braid Constructions

Latest applications, standard terminology, and types of tubular and flat metalbraid constructions are described and illustrated. Formulas are given for designating construction, braid angle, pitch, percentage coverage, and picks per inch. Several types of braid weaves are described, and some typical applications are shown. Brochure TB301, 4 pages. National-Standard Co., Dept. RDT, Niles, Mich. Circle 604 on Page 19

Differential Gearing

Two brochures cover Specon differentials and differential transmissions. "Principles and Applications—Specon Differential Gearing" outlines principles of operation, along with a speed, torque, and power analysis of the bevel-gear differential. Typical applications utilizing the differential gearing are illustrated. "Specon Differential Gearing and Differential Gear Boxes" outlines various sizes available in basic gearing and transmissions. Rating and dimension tables of standard and

special units available are listed. 8 pages. Stratos Div., Industrial Products Branch, Fairchild Stratos Corp., Route 109, West Babylon, N. Y.

Circle 605 on Page 19

Linkage Joints

Provides data on new hollow-steel ball joints and pivots for linkages in either static or dynamic applications. Points out various types of units, gives special features and applications. Catalog 611, 4 pages. Link-Age Corp., 115 Bennett Ave., Yonkers 2, N. Y.

Circle 606 on Page 19

Aluminum Screw-Machine Stock

Consists of four tabbed sections which cover general information, properties and tolerances, estimating information, and toeling and operating data. Summarizes mechanical and physical properties and machining characteristics, and lists sizes, tempers, and applications for each of the five standard aluminum screw-machine stock alloys. Also includes complete weight tables, screw-thread data, recommended cutting fluids and lubricants, tool description, and finishes, 154 pages. Aluminum Co. of America, 728 Alcoa Bldg, Pittsburgh 19, Pa.

Circle 607 on Page 19

Lubricating Grease

Summarizes basic principles, properties, types, and rules for choice and application of lubricating grease. Includes discussion on the effect of additives on the properties of grease. 32 pages. Bardahl Mfg. Corp., 1400 N. W. 52nd St., Seattle 7, Wash.

Circle 608 on Page 19

Universal Drive Tensioner

Describes base and shaft-mounted units with new bronze-bushed idlers. Includes data on use of the drive tensioner, and tips on idler usage. Bulletin 7161, 4 pages. Brewer Machine & Gear Co., 1441-43 N. Second St., St. Louis 6, Mo.

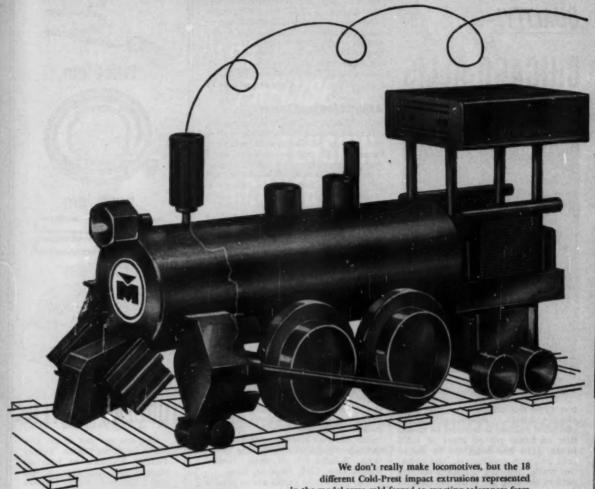
Circle 609 on Page 19

Light Metals

Design data on characteristics and properties of light metals, including magnesium, aluminum, and titanium, are set forth. Lists comparative values for various metals, presents metals in tabular and graphic form. 44 pages. Brooks & Perkins Inc., 1950 W. Fort St., Detroit 16, Mich.

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October 12, 1961

Circle 336 on Page 19

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HELPFUL LITERATURE

Shock Absorbers

Covers cylinder and mounting dimensions and operating range, includes related technical data and performance curves. Also contains a check list which, when filled out, provides data needed to recommend a standard shock absorber, to modify a stock model, or to design a completely new model. "Shock and Vibration Control Equipment." 20 pages. Ellis Fluid Dynamics Corp., 7344 Monticello, Skokie, Ill.

Circle 611 on Page 19

Adjustable-Speed Drives

Covers definition, selection, comparison of adjustable-speed drives. Brochure deals with product description and application, factors in drive selection, and examples of and recommendations for special applications. Complete line of adjustable-speed drives, ranging from 1/20 to 1000 hp, is covered. Bulletin GEA, 32 pages. General Electric Co., Schenectady 5, N. Y.

Circle 612 on Page 19

TFE O-Rings

Lists over 250 sizes of TFE O-rings. Nominal dimensions of ID, OD, and width are given, along with actual decimal dimensions and tolerances for ID and width. Rings are classified by SAE ARP-568 dash numbers; packing and gasket numbers for AN-6227 and AN-6230 are given where applicable Catalog P. 1A, 4 pages. Chicago Gasket Co., 1271 W. North Ave., Chicago 22, Ill.

Circle 613 on Page 19

Conveyor-Belt Engineering

Statistical data and tables for calculating, engineering, and selecting conveyor belting are included. Presents new condensed horsepower formula. Illustrates typical conveyor problems, and gives belt recommendations for deteriorating conditions. Bulletin 175, 24 pages. Hewitt-Robins, Dept. CBE, Stamford, Conn.

Circle 614 on Page 19

Fluid Steering Control System

Orbitrol system, which eliminates any mechanical linkage to the axle, consists of a fixed-displacement rotary metering motor, a commutator-feed valve sleeve, and a selector-valve spool. Bulletin illustrates and describes the system, and includes selection data, specifications, and applications. 8 pages. Char-Lynn Co., 2843 26th Ave. S., Minneapolis 6, Minn.

Circle 615 an Page 19

Power Supplies

Describes high-efficiency, compact, highly regulated dc-power supplies. Switching preregulator, which offers essentially loss-less regulation, is explained, including its application as a power-supply preregulator. Includes modular, rack, and cabinet models for both OEM and laboratory applications. Catalog PS 961, 16 pages. Valor Instruments Inc., 13214 Crenshaw Blvd., Gardena, Calif.

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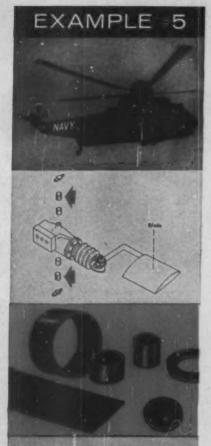
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Gyroscopic Instruments

Revised edition of "Technical Information for the Engineer—Gyros" details the theory, performance, application, construction, and testing of gyroscopic instruments. Drift phenomena and advanced gyro designs are also discussed. 60 pages. Kearfott Div., General Precision Inc., 1150 McBride Ave., Little Falls, N. J.

Circle 617 on Page 19

High-Strength Steel

Vascojet M-A provides tensile strength values above 360,000 psi with safe ductility. Brochure contains detailed engineering data on the steel, and lists applications. 20 pages. Vanadium-Alloys Steel Co., Latrobe, Pa.

Circle 618 on Page 19

Structural Damping

Describes damped laminates for control of structural resonant response. Presents advantages of standard and custom-engineered Dyna-damp structures in protecting sensitive equipment exposed to random, high-intensity vibration, shock, and noise. Explains basic considerations in design and selection of protection systems to combat structural fatigue, component malfunction, and low reliability. Includes information on Dyna-damp structural forms and shapes and printed-circuit boards. Bulletin 719, 8 pages. Lord Mfg. Co., Erie, Pa.

Circle 619 on Page 19

Lubricating Devices

Provides specifications and operating descriptions of automatic oilers, chain oilers, dispensers, single and multiple valves, mist systems, industrial fuses, and fuse accesories. Includes recently developed new products. Catalog 61, 12 pages. Trico Fuse Mig. Co., 2948 N. 5th St., Milwaukee 12, Wis.

Circle 620 on Page 19

Shaft-Mounted Reducer

TDO25 shaft-mounted speed reducer is designed for shaft diam. of 1½ in. or less and for power requirements to 1 hp at 90 rpm. Bulletin includes engineering drawings, dimensions, weights, prices, and table of horsepower ratings for various classes of service. Table of recommended V-belt drives permits easy selection of total speed ratios to 175:1. Bulletin 602A, 4 pages. Dodge Mfg. Corp., Mishawaka, Ind.

Circle 621 on Page 19

Control Valves

Describes control valves in sizes from ½ to 6 in. in ductile iron, cast iron, cast steel, stainless steel, bronze, Monel, and aluminum. Gives pressure and temperature ratings, features, capacity charts, names of parts, dimensions, flow chart, diagrams of various hook-ups, and sample specifications. Catalog DVC-1, 8 pages. OPW-Jordan, 6013 Wiehe Rd., Cincinnati 37. Ohio.

Circle 622 on Page 19

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Circle 341 on Page 19

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Circle 342 on Page 19



HELPFUL LITERATURE

Brasses and Tin-Brasses

Contains data on composition, specifications, and properties for six grades of brass wire, rod, and strip. List of some typical applications is included. 6 pages. Riverside-Alloy Metal Div., H. K. Porter Co. Inc.

Circle 623 on Page 19

Fluid Filters

Use of Tell Tale filters with fire-resistant fluids reduces pressure drop in the suction piping and permits use of finer suction filters. Catalog points out the design characteristics and special features, includes selection chart and data sheets. 8 pages. Rosaen Filter Co., 1776 E. Nine Mile Rd., Hazel Park, Mich.

Circle 624 on Page 19

Chain Lubrication

Provides general recommendations and suggestions for lubrication of power-drive chains as well as conveyor and elevator chains, and includes a table of engineering data. Specific methods of chain oiling are presented, and several ideas are outlined for lubrication of high-temperature chains. Chain cleaning is also discussed. Bulletin 1800, 8 pages. Oil-Rite Corp., 2376 Waldo Blvd., Manitowoc, Wis.

Circle 625 on Page 19

Servo Components, Packages

Presents outline drawings and tabulations of electrical characteristics for standard servo motors, acceleration-damped motors, velocity-damped motors, standard tachometers and motor tachometers, shortmotor tachometers, temperature-compensated motor tachometers, hirth-performance motor tachometers, synchros, pancake synchros, resolvers, miniaturized-transistor servo amplifiers, and gear trains. 16 pages. Transicoil Div., Daystrom Inc., Worcester, Montgomery County, Pa.

Circle 626 on Page 19

Bronze Parts

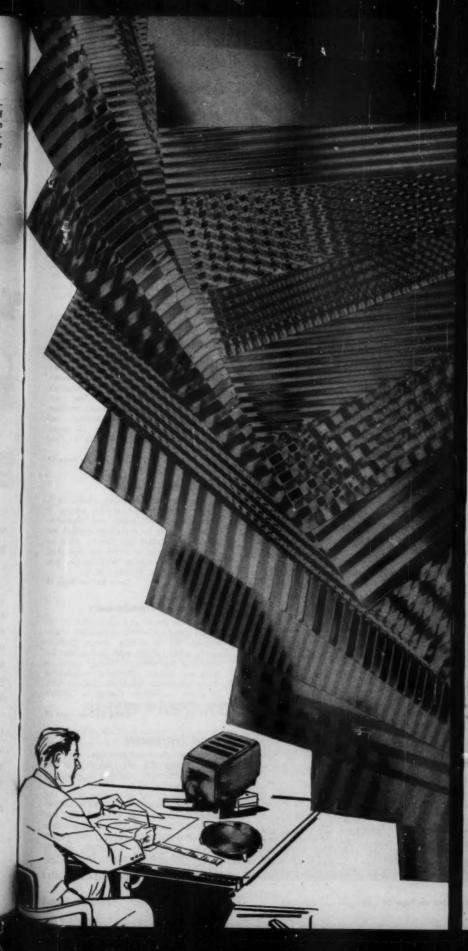
Explains how Continucast process for producing bearing-bronze parts can provide quality and savings over those made from sand-cast SAE alloys. Brochure lists physical properties of Continucast SAE 660 and wide range of other SAE bronze alloys available from the process. Bulletin JBL-36, 4 pages. Johnson Bronze Co., New Castle, Pa.

Circle 627 on Page 19

Spray Nozzles

Gives information on AutoJet automatic spray nozzles for hydraulically atomizing sprays at operating pressures to 600 psi. Points out choice of interchangeable orifice tips which permits selection of flat, hollow-cone, and full-cone spray patterns. A typical installation is schematically illustrated and described, along with accessory equipment. Bulletin 115, 4 pages. Spraying Systems Co., 3274 Randolph St., Bellwood, Ill.

Circle 628 on Page 19



FOR PRODUCT GLAMOR, FOR EYE APPEAL and SALES APPEAL DESIG

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Design excitement and producbesign exercises and produc-tion economy... both are yours when you specify American Nickeloid's lustrous pre-plated metals!

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These metals can be bent, riveted, drawn, beaded, flanged, etched, welded, punched, lithographed, silk-screened, seamed, stamped, or folded.

Write today for your free Intro-ductory Kit, which contains specifications and fabrication data, plus a consulting file of metal samples. Your letter will start you on an exciting journey into the world of American Nick-eloid pre-plated metals.



Circle 344 on Page 19

70 HORSES, EAGER AND RUGGED

Jeep F. HEAD

America's only 4 cylinder, P-head Engine offers you unusual performance advantages. Its large intake valves contribute to superior "breathing" qualities, and its intake manifold design preheats the fuel mixture. The result is extra efficiency... and extra power.

add to this, the rugged Jeep Engine features offered as standard equipment, at no extra cost. There are positive valve rotators, positive crankcase ventilation, stellite or eatonite exhaust valves and seats...and more. The 'F-head's power and weight often permits it to replace a heavier 6 cylinder engine with all the contingent savings in cost.

22.5 to 70 maximum brake horsepower.

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Manufacturers

Small-Diameter Tubing

Sets forth sizes, specifications, finishes, tolerances, chemistry, and suitable applications of small-diameter tubing line to lin. OD. Covers stainless steel, nickel, nickel alloy, exotic alloy tubing, tubular fabricated parts. Bulletin 13, 18 pages. J. Bishop & Co., Platinum Works, Malvern, Pa.

Circle 629 on Page 19

Ball and Roller Bearings

Clearly defines and illustrates ball and roller-bearing parts and terms. Other subjects include ball installation, dimensions, loads, alignment, types, and functions of self-aligning, nonself-aligning, and thrust bearings. Bearing accessories are also described. Form 343, 24 pages. SKF Industries Inc., Front St. & Erie Ave., Philadelphia 32, Pa.

Circle 630 on Page 19

Silicone Diodes, Rectifiers

Describes line of filicon diodes and rectifiers. Semiconductors available are diffused-junction silicon diodes in general-purpose, high-conductance, computer-switching, and standard types. Also available are diffused-junction silicon rectifiers in glass package, coaxial package, and epoxy package. Bulletin 514, 10 pages. Erie Resistor Corp., 644 W. 12th St., Erie, Pa.

Circle 631 on Page 19

Wire Cloth

Illustrates and describes plain, twill, Dutch, micronic, and special weaves of wire cloth. Specifications and characteristics of coarse to extra-fine meshes are presented in tables and curves. Uses for the various types of cloth are described. 16 pages. Unique Wire Weaving Co., Inc., 726 Ramsey Ave., Hillside, N. J.

Circle 632 on Page 19

Differential Transformers

Discusses theory and application of Atcotran linear variable-differential transformers for measuring linear displacements, gives pricing, engineering, and installation instructions. Military specifications and special differential transformer characteristics are tabulated. Bulletin 6208, 12 pages. Automatic Timing & Controls Inc., King of Prussia, Pa.

Circle 633 on Page 19

Panel Instruments

Discusses features, selection, and uses of improved 2½ and 3½-in. matched panel instruments available in round or square Bakelite cases. Units are available in dc, rf, and ac-rectifier types, and in moving-iron ac types. Data on dimensions, availability of shielded and unshielded types, accuracies, power consumption, and expanded-scale types are included. Bulletin 01-111, 6 pages. Weston Instruments Div., Daystrom Inc., Newark 12, N. J.

Circle 634 on Page 19

UNSHAKEABLE SELF-LOCKING PERFORMANCE IS BUILT INTO AN ELASTIC STOP NUT



Start with a standard hex nut and add a metal crown . . .



Add "the ring of reliability"—
the easily identified ESNA red nylon locking insert . . .



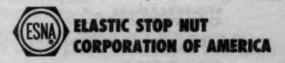
Then roll the crown over smoothly and stake—
the insert is made an integral part of the Elastic Stop nut

BUILD FASTENER RELIABILITY INTO YOUR PRODUCT!

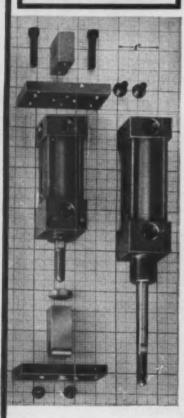
Take an Elastic Stop nut and mount it on one of your products where vibration is really severe. Shake the daylights out of it in the roughest torture test you can devise—or better still—send it into the field where it's subject to regular use and abuse.

Here's what you'll find: That Elastic Stop nut will stay put! The bolt threads are impressed into the nylon locking collar with such a perfect fit that internal liquid seepage is sealed off. Internal nut and bolt threads are protected against corrosion. The nylon insert locking torque is so smooth that it never galls or distorts bolt threads; and nylon is so wear-resistant that under normal usage you can wrench

the nut on and off the bolt 50 times or more and the nut will still remain tight under vibration! Protect the performance and the reputation of your product by guaranteeing fastener reliability. Try it yourself and see. Send for free test samples. Just tell us the size. Dept. S53-104, Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.







Hannifin offers new "Midget-Air" 200 psi cylinders in ¾", 1" and 1¾" bores, double-acting or spring-return. Two basic models, "universal" and "nose-mounting." Universal models come drilled and tapped for mounting, or for use with any combination of the mounting attachments pictured. Delivery is off-shelf in standard strokes, shipment in ten days to specified stroke lengths. Want dimensions and prices? Write:



\$15 South Wolf Road * Des Plaines, Illinois EUROPEAN DIVISION - PARKER-HANNIPIN N.V. SCHIPHOL - THE NETHERLANDS

Circle 347 on Page 19

HELPFUL LITERATURE

Silicon Rectifier

Specification sheet covers IN3289-IN3295 high-current silicon rectifier. Contains 19 curves including NEMA overload ratings. Curves depict cell specifications, maximum circuit ratings for cells mounted on 5 x 5 x ½-in. and 7 x 7 x ½-in. copper fins, and recurrent overload ratings for cells mounted on 7 x 7 x ½-in. copper fins. Shows how to calculate recurrent overload ratings for 7 x 7 x ½-in. copper fins or equivalent. Specification Sheet 145.15, 8 pages. Rectifier Components Dept., General Electric Co., W. Genesee St., Auburn, N. Y.

Circle 635 on Page 19

Miniature Components

Covers new lines of bearings, limit stops, slip clutches, gearing, and shafts. Includes all specifications and availability information. Catalog 461, 18 pages. Northfield Precision Instrument Corp., 4400 Austin Blvd., Island Park, L. I., N. Y.

Circle 636 on Page 19

Brass Strip

S-19 brass strip has a fine grain, is uniform in structure, and is scratch and dent-resistant. Brochure includes photograph and chart comparisons of S-19 brass with conventional deep-drawing brass. Typical applications for the special-process strip are given. 4 pages. Chase Brass & Copper Co., Waterbury 20, Conn.

Circle 637 on Page 19

Temperature Transducers

Discusses Tanatherm interchangeable surface-temperature transducers designed for installation on smooth surfaces which cannot be disturbed mechanically or subjected to heat. Points out various types, lists temperature range, dimensions, accuracy, and other data. Special Product Note 2342, 4 pp. Trans-Sonics Inc., P. O. Box 328, Lexington 73, Mass.

Circle 638 on Page 19

Switch, Thermostat Packages

Forty-two Klixon precision switch packages and thermostat packages are shown in each of two revised technical bulletins. Included are photographs and dimensional drawings of representative packages. Bulletins PRSW-10B, PRET-26, 16 pages. Metals & Controls Inc., Div., Texas Instruments Inc., 34 Forest St., Attleboro,

Circle 639 on Page 19

Multiple Connectors

Describes three separate lines of multiple connectors, and includes specific data sheets for each of the lines. Covers Fastin-Faston, Ampez, and Amp-Lok units. Data sheets give complete specifications on contact sizes and materials, wire crimp and insulation support, wire and insulation size ranges, receptacles, and housings. 6 pages. AMP Inc., Eisenhower Blvd., Harrisburg, Pa.

Circle 640 on Page 19

PICK THE ALLOYS

AIR MELTED

Low Alloy Series, including: 4100, 4300, 8600

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300 Series Stainless, including: 302, 303, 304, 310, 316, 347

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Rasic Switches

Describes Type M, 22-amp, steady-state, current-capacity switch which has 0.001-in. maximum differential travel and 0.005-in. minimum overtravel. Data sheet includes photograph, dimension drawing, complete electrical data, and operating characteristics. 2 pages. Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle 641 on Page 19

Heat Exchangers

Provides information on a line of stockmodel compact heat exchangers. Describes construction features providing improved performance and reliability over a wide variety of applications. Standard sizes, dimensions, and weights are listed for one, two, and four-pass exchangers. Bulletin F-1161, 4 pages. Basco Inc., 345 Payne Ave., North Tonawanda, N. Y.

Chale 642 on Page 19

Germanium Diodes

Gives characteristics and physical specifications for approximately 150 subminiature Gold Bonded glass diodes, including computer types, high reverse-resistance types, and high forward - conductance types. Color coding information for all diodes is included. Bulletin A-101, 4 pages. National Transistor Mfg. Inc., 500 Broadway, Lawrence, Mass.

Circle 643 on Page 19

Digital Transducers

Dynapar Digital Rotopulsers for precise industrial measurement and automatic control are available for requirements to 2400 pulses per rotation. Bulletin presents information and application data on the transducers that convert motion into pulses. Bulletin 200-A, 4 pages. Louis Allis Co., Dept. P, 427 E. Stewart St., Milwaukee 1, Wis.

Circle 644 on Page 19

Numerical Control System

Describes Command Control tape-control system designed for attaching to existing machine tools and other applications calling for tape-fed sequential operations. Explains how the system operates, shows all component parts, 4 pages. Electro-Mechanical Div., Lear Inc., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.

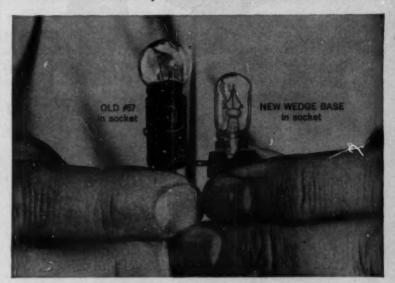
Circle 645 on Page 19

Control Centers

Provides guide for laying out and designing any control center, special or standard. Individual units can be added or modified. Work sheet and application guide are included for easy design. Discusses how to arrange units within the structure for maximum efficiency. Bulletin C-6300, 16 pages. Monitor Controller Div., Atleet Corp., 99 Grove St., Rockland Mass.

Circle 646 on Page 19

NEW G-E "WEDGE BASE" LAMP SAVES SPACE, SAVES MONEY, SAVES TIME, SAVES MANPOWER



The new "Wedge Base", all-glass, incandescent indicator lamp is an exclusive G-E development designed to replace the old #57 and other similar bayonet-based lamps. It's available in 6.3 and 12 volts. See below.

The Wedge Base saves space because, with its holder, it is considerably smaller than the old \$57. It saves money because the holder and total installation costs are less. It saves time because the holder is easier to install and the lamp can be seated with just a push. And it saves manpower because installation can be automated and holders can be molded into plastic circuits. The G-E Wedge Base lamp can withstand ambient temperatures up to 600°F because it has no basing cement.

A major automobile manufacturer is already using G-E Wedge Base lamps; they're available in mass quantities. For more information write: General Electric Co., Miniature Lamp Department M-12, Nela Park, Cleveland 12, Ohio.

The Wedge Base is available in two ratings

The weage base is available	in two ratings
Q.E. Lamp No. 158 159	T
Circuit Volts 12 6.3	1) (1)
Amperes 0.24 0.15	M 11 17 11
Design Volts 14 6.3	M = M = M
Rated Av. Life	AIA II W I 13."
at design volts 500 Hrs *	
Filament C-2V C-2R	HITI
L.C.L	AILII
Bulb T-314 . T-314	THE DATE I
Base Type Wedge . Wedge	1 181 1821
Candlepower 2	
*In excess of 5000 hrs. at 6.6 volts	0 . 1
	- 0.4 - or

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Differential Pressure Devices

Covers line of bellows-type differential pressure instruments used in various fields. Pictures the units, gives data on specifications. Bulletin G-61, 28 pages. Industrial Instrument Corp., P. O. Drawer 777, Austin, Tex.

Circle 647 on Page 19

Speed Changer

Two bulletins describe design features of the Vari-Tex speed changer. Literature details choice of mechanical, electrical, and pneumatic control options. Bulletins 51B9061B, 51B1042, 6 pages. Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

Circle 648 on Page 19

Servo-Motor Package

Developed for use in missile and aircraft-control systems, servo-motor package incorporates hydraulic motor, servo valve, and internal relief valves in one housing. Bulletin includes complete details on design features and operating characteristics. Typical torque-speed characteristics are shown in curve form, and no-load static hysteresis loop is reproduced. Hydraulic schematic drawing and dimensioned outline drawings are included. Bulletin A5261, 4 pages. Aero Hydraulics Div., Vickers Inc., Div., Sperry Rand Corp., Detroit 32, Mich.

Circle 649 on Page 19

Silicone-Rubber Insulation

Describes various silicone-rubber compounds available for use as wire and cable insulation. Tables show typical properties of silicone rubber. Provides suggestions for handling compounds, pictures silicone-rubber and wire and cable constructions and applications. Discusses silicone-rubber gums, available for fabricator mixing. Write on company letterhead to Silicone Products Dept., General Electric Co., Waterford, N. Y.

Precision Balls

Including comprehensive technical data on line of precision balls and related bearing products. Also contains reference material such as AFBMA definitions, cross-reference charts for previous and present AFBMA standards, and table of ball grades and tolerances. 14 pages. Write on company letterhead to Hartford Steel Ball Co., 12 Jefferson Ave., West Hartford, Conn.

Miniature Ball Bearings

Covers miniature bearings produced in standard types and sizes from 5/32 to ½ in. OD for applications requiring critical tolerances and optimum performance characteristics. Details functional characteristics, standard tolerances, fitting practices, calibration, and lubrication specifications for each bearing. Other material includes thrust and radial loads, ball-bearing life and carrying capacities, and interchange data. Write on company letterhead to Microtech Div., Federal-Mogul-Bower Bearings Inc., 1201 N. Arden Drive, El Monte, Calif.



QUICK DISCONNECTION

with instant automatic shut-off

...prevents loss of liquid, gas, or pressure



Write for the Hansen Catalog

Here is an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings—including Special Service Couplings for LP-Gas, Steam, Oxygen, Acetylene, etc.



As easy as plugging in your electric shaver...

To connect a Hansen Two-Way Shut-Off Coupling, you merely pull back the sleeve and push the Plug into the Socket. To disconnect, just pull back the sleeve. No tools required. When Coupling is disconnected, similar valves in Socket and Plug shut off both ends of fluid line circuit—practically eliminating spilling of fluid at instant of disconnection.

Available in brass or steel, with female pipe thread connections from ½" to 1½" inclusive. Sizes through 1" are also available in stainless steel.

Representatives in Principal Cities ... see Yellow Pages

THE HANSEN MANUFACTURING COMPANY

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NEW-TWO LOW-COST MINIATURE BALL BEARING LINES

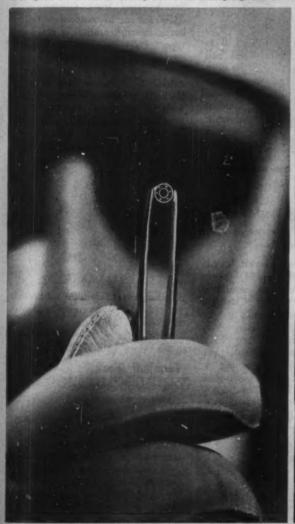
New Departure ABEC 3* and ABEC 5* miniature ball bearings now offer manufacturers of precision miniature potentiometers, gear trains, motors and similar precision products the opportunity to reduce bearing costs substantially.

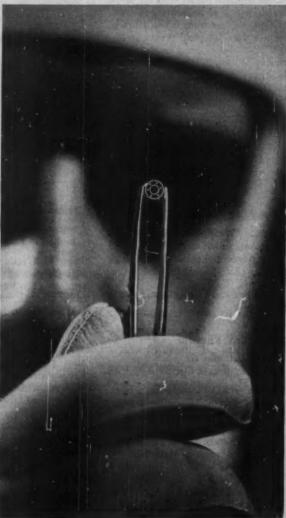
New Departure ABEC 3 and ABEC 5 bearings can be used wherever the high precision and performance of ABEC 7 bearings are not required. They offer the engineer greater design versatility—he can select the most economical bearing for each application. Moreover, New Departure ABEC 3 miniature ball bearings can be used to upgrade products presently using precision sleeve bearings.

New Departure will continue to offer super precision ABEC 7 miniature ball bearings for your highly critical applications.

If you are planning a re-evaluation of your miniature bearing applications, it will pay you to consult the N/D Sales Engineer in your area. His assistance may help pave the way to reduced parts cost or enhance the quality of your product. For more information, write for booklet AST, NEW DEPARTURE, DIVISION OF GENERAL MOTORS CORPORATION, BRISTOL, CONN.

*Bearing tolerances as established by the Annular Bearing Engineers Committee of the Anti-Friction Bearing Manufacturers Assoc.





NEW DEPARTURE MINIATURE AND INSTRUMENT BALL BEARINGS

New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Seamless Mylar Belts

for fractional and subfractional range

Suited for flutter and slip-free precision power transmission in fractional and subfractional horsepower range, seamless Mylar belts are made in lengths to 48 in., widths to 1 in., and thicknesses from 0.5 to 10 mils. Heat-treated for yield points to 18,000 psi, belts resist extremes of shock, vibration, temperature, and humidity. Capable of pretensioning on fixed centers, belts eliminate idler tightening and center adjusting pro-



visions. With direct drives from shafts as small as 0.040 in., 10:1 ratio stages are realized. Kinelogic Corp., 1256 N. Fair Oaks Ave., Pasadena, Calif.

Circle 650 on Page 19

Miniature Vibrator

has maximum air consumption of 6 cfm

Vibrolator BD-13, weighing 7½ oz, handles up to 10 cu ft capacity bins. It is used to bring powdered, particulate, or crystalline materials out of hoppers, down chutes, and through screens. Maximum air consumption is 6 cfm (free air at 80 psi), declining as the requirement for high-speed operation declines and air pressure is reduced. Unit operates on as little as 5 psi. Chrome-steel ball, driven in an orbit on replaceable raceways of hardened high-alloy steel, produces infinitely



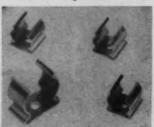
controllable frequencies from 0 to 22,000 cycles per min. Steel ball is the only moving part in the unit, which requires no auxiliary equipment. It can be used in explosive atmospheres and in high ambient temperatures. Lug design permits mounting in any position with a single bolt. Martin Engineering Co., Neponset, Ill.

Circle 651 on Page 19

Spring Tension Clips

retain electrical components in 0.10 to 1.12-in. diam

Type 14 (National Aircraft Standards Committee Type 1464) spring tension clips are now available from stock in 39 styles. Clips retain electronic components in diameters from 0.10 to 1.12-in. Materials are carbon steel per MIL-S-17919, No. 4, or beryllium-copper alloy per QQ-C-533, Condition A. Tensile strength of the carbon-steel clips ranges from 175,000 to 215,000 psi and of the beryllium-copperalloy units from 123,000 to 170,000 psi. Birtcher Corporation/Industrial



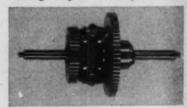
Div., 745 S. Monterey Pass Rd., Monterey Park, Calif.

Circle 652 on Page 19

Miniature Differential

in bevel-gear type

Stainless-steel stock differential B-53580 for use in computers and airborne instrumentation is bevel-gear type. Unit has four 64-diametral pitch, 20-degree pressure-angle bevel gears, each mounted on two class ABEC 5 or better ball bearings. Backlash is held to 30 min maximum with a 1.0 oz-in. reversing load. Breakway torque is 0.10 oz-in. Special differentials can be built with 5 min of backlash and 0.05 oz-in. starting torque for computers that



require high-precision components. Washington Scientific Industries Inc., 13111 Wayzata Blvd., Minneapolis 40, Minn.

Circle 653 on Page 19

Terminal Block

accepts all common lead terminations

Uni-Block terminal block accepts spade, ring, or fork lug, test probe, straight pin, and wire-wrap lead terminations. Top and side entry, with optional feed-through pins, permits fast positive connections. Terminal lug snaps into place, providing a positive electrical and mechanical connection with a withdrawal pressure of 35 to 40 lb. Tension can be varied with screw adjustment. Units can be placed end-



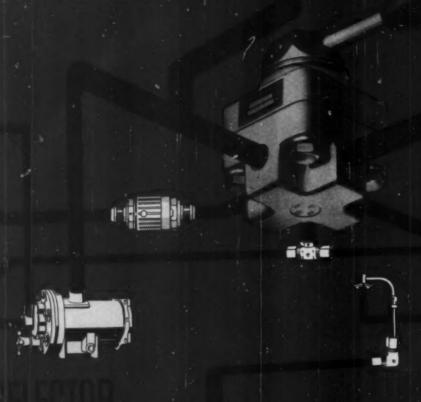
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New required reading for designers who specify precision measuring equipment Your surest source of quality measuring equipment is Lufkin... new leader in precision tools. This catalog shows and describes the comprehensive line-up of Lufkin Dial Indicators... part of a complete line of precision measuring tools available to you as original equipment. When you specify Lufkin you are assuring yourself of accuracy, dependability and long, trouble-free operation. Check 352 on the reader inquiry card for your free copy.

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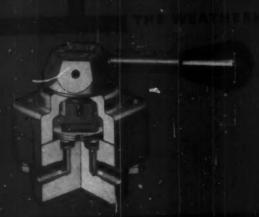


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Meet J.i.C., A.E., and M.S. standards Pressures to 3000 psi



Pressure Control, Autoratic (Constant) Flow Control Manual Displacement Control





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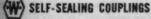
Fixed Displacement Hydraulic Motors, Reversible Variable Displacement Hydraulic Motors (Integrated Torque and Speed Control)





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NEW PARTS AND MATERIALS



to-end or side-by-side to provide any number of terminations in a relatively small area. Modular Electronics, 6211 S. LaBrea Ave., Los Angeles 56, Calif.

Circle 654 on Page 19

Powdered Epoxy Foams

can be used from -65 to +300 F

Powdered epoxy foams, designated Eccofoam EFF, are supplied as onecomponent, finely divided powders. Quantity of powder is introduced to a mold or cavity and moderately heated. Result is a rigid, uniform foam structure which completely fills the volume. Foams can be used in temperatures from -65 to +300 F. Epoxy properties are preserved. Three formulations are available: Eccofoams EFF-4 and EFF-10 partially fill the cavity initially and then expand; EFF-15 is poured as a powder to completely fill the mold. Emerson & Cuming Inc., Canton,

Circle 655 on Page 19

Miniature Flexible Coupling

couples two shafts in absolute unison

Metallic bellows serves as the flexible element in new miniature shaft coupling. Unit couples two shafts in absolute unison, without backlash or cyclic angular displacement during rotation. Corrosion-resistant, nickel bellows flexible element has high elasticity and low hysteresis.





HIGH-SENSITIVITY SWITCHING © LOW UNIT COST

highly reliable low wattage relays from LIONEL

solder lugs or plug-in terminals for printed circuit boards

insulating bases and dust covers optional

TYPICAL UNIT

Rating: 50 milliwatts
Impedance: 2300 ohms
Pull-in current: 4.7 ma
Drop-out current: 1.0 ma
Electrical specifications
can be changed to suit
application.

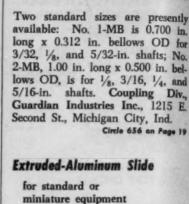
Send for data on "4325 SERIES" RELAY Write Dept. 310-R



LIONEL ELECTRONICS DIVISION

Hillside, New Jersey

Circle 354 on Page 19



Micro-Slide, a three-section, extruded-aluminum slide is a small, thin, ball-bearing unit made for standard or miniature equipment. Rated at a minimum load capacity of 100 lb per pair, slide supports most electronic and industrial equip-



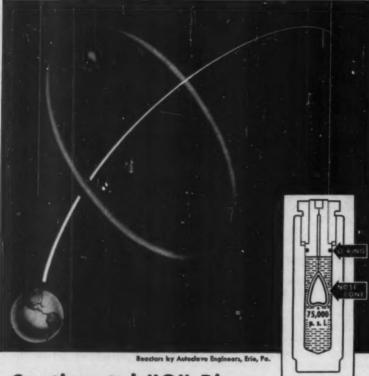
ment. It is 5/16 in. thick by 15/8 in. high, and can be used in restricted-space areas, Grant Pulley & Hardware Corp., High Street, West Nyack, N. Y.

Circle 657 on Page 19

Load Cell

is actuated by deflections as small as 0.001 to 0.005

Self-contained Force Control Cell is available for precise control of machine tools and materials-handling processes. It is actuated by deflections as small as 0.001 to 0.005 in. and can be custom-made to respond to even smaller deflections. The 4in. high unit offers a means of controlling or detecting compression or tension in a production setting. It is available in 16 standard models in three series, with capacities from 500-1000 to 75,000-500,000 lb. Unit sustains overloads up to four times Standard cell its rated capacity. has one knob control, which is preset at any desired load. Control knob reads directly in pounds of



Continental "O" Rings Help Put Satellites in Orbit

Almost as dramatic as the thrust of a satellite into outer space is the technique used to fabricate the nose cone of the missile. These nose cones, made either of powdered metals or refractory materials, are being compacted in 12" I.D. pressure vessels under hydrostatic pressure of 75,000 P.S.I. Imagine the problem involved in sealing a vessel against such terrific pressure!

Yet THAT is the problem solved by this Continental "O" Ring. Obviously an ordinary "O" Ring would not do. The job called for a special compound with molecular formation so precise that separation or micro-leakage just could not occur. Continental developed the compound that meets this rigid test. What's more, the elasticity of the rubber refuses permanent set and thus permits re-use of the ring.

This unusual rubber problem typifies the complete engineering service available to you here at Continental. Whether you need molded or extruded rubber parts, consult with us while your new products are still on the board. Let us suggest how you might save both tooling and material costs-and get a better product for the job.

Hydrestutic Pressing (see diagram).

A technique for producing uniform compaction and grain structure to obtain super hardness and impact resistance in critical components. A steel forming-mandrel is coated with a refractory material, placed in a rubber bag and suspended in pressure vessel. Pressure is applied until required density is

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.





lo. elnd v., E.

force. Cell is accurate to within 3 per cent of its maximum rating, has repeatability within 1 per cent. Maximum service temperature is 175 F. Force Controls Co., 424 W. Eight Mile Rd., Ferndale, Mich.

Circle 658 on Page 19

Dry-Casting Compound

has high thermal conductivity

Dri-Cast one-component, epoxybased material in dry-powder form provides easy handling in potting applications. It has excellent electrical characteristics and high thermal conductivity. Low shrinkage and low coefficient of thermal expansion approach inorganic materials in value. Thermal and physical shock properties are excellent. Hysol Corp., Olean, N. Y.

Circle 659 on Page 19

Synchronous Motor

drives large inertial masses at constant rate of speed

Type 5003 dual-speed, hysteresis-synchronous motor offers stable outputs of 300 or 600 rpm insensitive to voltage changes. Device drives large inertial masses at a constant rate of speed. Operable within a temperature range of -65 to +165 F, motor supplies 9 oz-in. of synchronous rotor torque. Input voltage is rated at 115 v, single phase, variable 40 v in either direction;





here's helpful selection and use data on

THE CREAM OF OVER

Just off press, this 36-page Stackpole Catalog 13-A is a practical guide to composition contact grades, presibilities, properties, uses, shapes, sizes . . . even contact attachment methods.

By molding contacts from two or more metal or carbon-graphite powders, Stackpole Custom Engineering obtains a maximum of the advantages of each material and minimizes its disadvantages. The result is a greater overall efficiency than is generally possible with a single solid metal or alloy. Many of the most desirable contact metals cannot, of course, be alloyed satisfactorily but they can be made from powders in almost any desired proportion.

Composition contact engineering under exclusive Stackpole processes is characterized by its extreme flexibility in obtaining exact needed properties. This is best evidenced by the fact that over 1500 different grades representing different metallurgical mixtures have been produced for specific applications.

In various instances, their advantages permitted increased equipment ratings. In others, they paved the way to smaller, less costly equipment. Often, they simply combined long, trouble free operation with maximum economy.

This Booklet by no means attempts to present composition contacts as a universal answer to all problems. However, for design and production engineers who appreciate the basic logic behind them and who recognize that conventional contact types often leave something to be desired, it will provide a wealth of helpful information and guidance.

A copy may be obtained on letterhead request (ask for Catalog 13-A) to: STACKPOLE CARBON COMPANY, St. Marys, Pennsylvenia.

STACKPOLE

CUSTOM ENGINEERED CONTACTS



Also: BRUSHES for all rotating electrical equipment; GRAPHITE CHEMICAL ANODES
BEARINGS • SEAL & CLUTCH RINGS • VOLTAGE REGULATOR DISCS • FRICTION SEGMENTS
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WHAT YOU SHOULD KNOW **ABOUT** STAND-OFF FASTENERS

for tubing . piping . conduits · wire bundles · support of equipment and instruments.

FREE!

CONTENTS ...

NOT A SALES BOOKLET

An objective analysis in the fastener field

- Small Fasteners are important business Advantages and disadvantages of
- Anvantages and disadvantages of various fastener materials Causes of failures of stand-off fasteners When is strength important?

- Weight saving Awkward shapes A minimum of drilling in structural material is desirable, "The Swiss
- material is desirable, "The Swiss Cheese Effect"
 When he use special types installation costs the bugaboo. Tips on how to cut costs.
 Migh cost of unnecessary re-work Removal a headache or a cinch How to compare costs of fasteners How to select stand-off fasteners.

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J. PHAND	ERIE	COU			
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Engineer____ Student____ Other_

NEW PARTS AND MATERIALS

power input is given as 28 w maximum. Designed as a direct drive for high-fidelity audio tapes and tape recorders, motor is also finding application with video tapes, data tapes, remotely controlled missile stations, and astronautical devices. It is suitable for master recording systems, as well as for driving tuning capacitors and test equipment. Beau Electronics Inc., Waterbury, Conn.

Circle 660 on Page 19

Overload-Release Clutch

incorporates torqueselector dial

Trig - O - Matic overload release clutch incorporates a torque-selector dial which facilitates the selection of different torque values. Predetermined torque limits are select-



ed by a turn of the torque selector dial to its indicated milled depth location. Minute adjustments between predetermined settings can also be made. Indicated maximum torque limit protects against clutch lock-out. Centric Clutch Co., P. O. Box 175, Woodbridge, N. J.

Circle 661 on Page 19

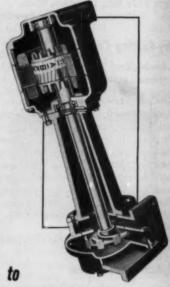
Seal-Bellows

for high-temperature applications

Close-tolerance, contour-controlled seal-bellows perform the triple function of seal, spring, and bellows expansion joint in high-temperature aircraft and missile industry applications. Seal-bellows are Inconel X, which retains its con-RARWolled spring force at operating temperatures to 1800 F. Thickness is about 0.010 in, and tube diameters are 4 to 10 in. Sealing

Gusher

Coolant Pumps PRECISION



LAST LONGER

PERFORM BETTER ON YOUR MACHINES

You get better performance from your GUSHER Coolant Pumps because they are precision built. The one piece shaft in GUSHER Pumps is electronically balanced to cut vibration to a minimum. Ball bearings are pre-lubricated, no seal or packing needed. Write for catalog.



MACHINERY CO.

COOLANT PUMPS CIRCULATORS - AGITATORS MOLTEN METAL PUMPS

1811 Reading Road . Cincinnati 2, Ohio

FOUR NEW UNIVERSAL ELECTRIC FRACTIONAL H.P. MOTORS

featuring Free-Aligning bearings

-either sleeve or ball

UNIVERSAL ELECTRIC

Type 23 4 pole sleeve bearing Type 63 6 pole sleeve bearing Type 523 4 pole ball bearing

Type 563 6 pole ball bearing

Primarily because of their new bearing assemblies (free aligning sleeve or free aligning ball), these four new UNIVERSAL motors operate at a reduced noise level, start easier and assure on extremely long operating life. They insure maximum performance and efficiency for kitchen ventilators, unit heaters, evaporative coolers, condenser fans, refrigerated cabinets, etc. These UNIVERSAL ELECTRIC motors also offer the perfect flat speed torque curve necessary for critical air moving or recorder applications.

UNIVERSAL Bail Bearing Assembly is re-illently suspended in a neoprene collar confined in small metal clips that allow free movement along bearing support surface. With axis of support at its center, bearing can adjust to any shaft misalignment. Advantages: reduced noise level, easier starting, no snap rings or shoulders or undercuts for steenger motor shaft, no pre-loaded bearings due to misalignment for free-cunning motor, longer metar life.



UNIVERSAL Sleeve type bearing eliminates flap motor bearing problems due to misalignment. Like ball bearing assembly, sleeve bearing is inherently in balance; can adjust to any shaft misalignment 100% of the time under any load conditions.

SPECIFICATIONS

Shaft Diameter—Hs or 1/4 Inches

Acountings—4 point on 221/2" or 31/2" (either end of motor)

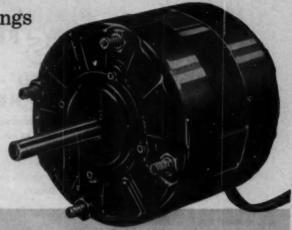
Either Fan or Mechanical Duty; Internal Fan Available

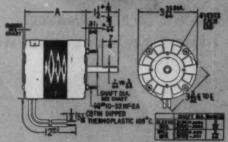
All Angle Operation

Cases—Drawn steel, formed and embossed for maximum rigidity, compact, rugged design

Rotor—Discust and machined to precision tolerances

Dual and Three Speed Windings 115 or 230 volt, 50 or 60 cycle Totally Enclosed Types Available Compiles with CSA and U/L Requirements





4 POLE SPECIFICATIONS

Model			Watts	Amps.		
Sleeve	Boil	H.P.	Speed	Input	Input	"A"
2356	523E6	1/50	1550	45	0.8	211/6
2388	52388	1/35	1550	80	1.0	23%
23E10	523E10	1/25	1550	105	1.4	27/6
23E12	523E12	1/15	1550	165	2.2	3 %
23814	523E14	1/12	1550	210	3.0	319/2

4 POLE SPECIFICATIONS

Medel			Watts	Ampt.		
Sleave	Bell .	H.P.	Speed	Input	Input	"A"
6386	56386	1/60	1000	75	1.0	21%
63E8	563E8	1/40	1000	95	1.3	25%
43E10	563E10	1/30	1000	125	1.7	2%
63E12	563812	1/20	1000	178	2.3	3 1/2
63E14	563E14	1/15	1000	230	3.1	31%

Write for complete specifications on your requirements.

UNIVERSAL ELECTRIC COMPANY

PRECISION ELECTRIC MOTORS

EXECUTIVE AND GENERAL SALES OFFICES, OWOSSO, MICHIGAN, DEPT. 10



DO YOU IN THE SMALL PIPING PROBLEMS FIELD?

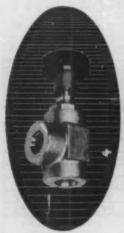
WE'D LIKE TO HELP YOU ... BUT WE NEED YOUR HELP

We're specialists in the small piping valve field...producing very high quality, precision-built valves for everyday as well as unusual applications. If you have a special problem that's giving you trouble, we'd like to hear from you...possibly we can help, either by suggesting one of our standard specialized valve items, or a slight modification.

Please write, giving us complete details. DO IT TODAY!

ROBBINS ARE PRECISION MADE FOR VALVES PERFORMANCE!

DESIGNED TO SAVE YOU MONEY!



HIGH PRESSURE



INSTRUMENT



THREE-PORT

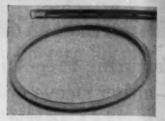
Here are three typically unique items in the Robbins Valve line. The high pressure valve operates up to 12,000 PSI, is pressure balanced, easily operated, panel mounts in one minute, serviced from front of panel. The instrument valve is really miniature... weighs only 0.31 lb., body is only 3" square, operates from hivacuum to 3500 PSI, provides absolute shut-off, low torque, fine metering control, leakproof operation. The three-port valve simplifies stocking problems...can be used as globe or angle valve (with sealing plug), or with relief valve, pressure gauge or another line connection in third port.



Write TODAY for 16-page illustrated brochure in color! AND...if you have a special problem in valving of small piping...include all details. We'd like to help.



3817 S. Santa Fe Ave. Los Angeles 58, California LUdlow 9-5221 NEW PARTS AND MATERIALS



surfaces are held flat and parallel within 0.002-in. tolerance. Initial production is in two-convolution units. Tube Turns Div., Chemtron Corp., 224 E. Broadway, Louisville 1, Ky.

Circle 662 on Page 19

Dowel Pins

in sizes as small as 0.0284 x 0.21 in.

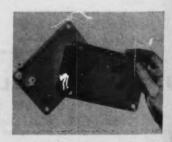
Stainless-steel dowel pins are coated with a moisture-protective film and packaged in clear-plastic bags to meet MIL Spec. C-16173B. Sizes range from $\frac{3}{4} \times 2\frac{7}{8}$ -in. to 0.0284 by 0.21-in. Designated MS-16555 Type 416 stainless steel, pins are corrosion resistant and nonmagnetic. Anti-Corrosive Metal Products Co., Castleton-on-Hudson, N. Y.

Circle 663 on Page 19

Printed-Circuit Grid Boards

in two new configurations in 4 x 6 and 6 x 8-in. sizes

Two new configurations in Fotoceram printed-circuit grid boards are now available. One has new cornermounting holes; the other has mounting holes plus a plug section, useful for computer-design work. Boards consist of copper-clad Fotoceram with a grid of 0.052-in. through-plated holes set 0.1 in. on center. Circuit pattern is laid out on the grid with etching resist, and copper lying beyond the pattern is etched away. Board is then ready



for components. Boards, equipped with silicone-rubber mounting grommets, are available in 4 x 6 and 6 x 8-in. sizes. Corning Electronic Components Div., Corning Glass Works, Bradford, Pa.

Circle 664 on Page 19

Swivel Fittings

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18

absorb vibration, shock, and thermal expansion

Standard, self-aligning swivel fittings permit the use of rigid metal tubing in aircraft and missile engines. Fittings absorb vibration, shock, and thermal expansion in rigid metal tubing, which provides



flexibility and reduces the possibility of flare breakage or loosening of connector nuts. Each fitting rotates 360 deg and has a movable nose which compensates for misalignment to 14 deg. Each unit operates at a relatively low torque and withstands temperature extremes and pressures to 5000 psi. Various sizes and configurations are available. Dumont Engineering Co., 1401 Freeman St., Long Beach, Calif.

Circle 665 on Page 19

Field-Effect Transistor

is high-input impedance, high-gain unit

Development Type TIX 690 field-effect transistor is an N-channel diffused-silicon device featuring dual-gate control. Transistor is a voltage-operated amplifying device which uses the depletion regions of back-biased N-P junctions to control the conductive thickness of a semiconductor layer. Result is a high-input-impedance, high-gain unit that has applications in the input stages of audio and dc amplifiers, switching applications, voltage-

MEEHANITE MEANS BETTER CASTINGS®





SOLVE YOUR TOUGH CASTING PROBLEMS WITH MEEHANITE NODULAR

The excellent castability of Meehanite Nodular in combination with exceptional strength, ductility and wear resistance has led to its wide acceptance for intricate pressure castings and many other components which must withstand severe service conditions. The broad range of its utility is further enhanced by inherent production advantages resulting in a reduction of manufacturing costs.

Meehanite Nodular is available in a broad range of properties embracing all current Nodular specifications and including some unique new wear and heat resisting types. When you specify one of the S types of Meehanite Nodular, you can be sure of obtaining castings that live up to specified claims. Meehanite foundries have more than a quarter of a century of experience in handling the essential materials used to convert the graphite in cast-iron from the flake form to the nodular which gives this family of metals its unique engineering properties. Meehanite patented quality controls assure uniform dependability regardless of how small or how large the casting.

For complete information about Meehanite Nodular, send for a free single copy of our eight page brochure (B-47-A). Write: Meehanite Metal Corporation, 714 North Avenue, New Rochelle, New York.



MEEHANITE METAL

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES.

NASHUA

approves high starting torque of

HEINZE

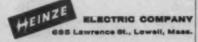
SMR

MOTORS

for new tape dispenser

Nashua Corporation's Vuematic tape dispenser which provides ready-to-use high quality sealing tape in positive lengths, relies on a motor with high starting torque. The Heinze SMR Universal Motor supplies this - plus long life. External brushes are easily accessible. Company executives state, "Our people in service, manufacturing and sales all endorse these fine motors which have been used by us for several trouble-free years of operation." Heinze Universal Motors are compact, have high starting and running torques, are versatile to allow all types of mounting arrangements and modifications, are uniform in quality, keyed to high production, and are competitively priced.

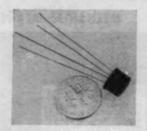
Write for complete catalog.



BUB-FRACTIONAL HORSEPOWER MOTORS AND BLOWERS

Circle 362 on Page 19

NEW PARTS AND MATERIALS



controlled resistances, voltage-controlled bandwidth amplifiers, and analog multipliers. Unit is packaged in a four-leaded TO-5 can, and is available in sample quantities. Semiconductor-Components Div., Texas Instruments Inc., P. O. Box 5012, Dallas 22, Tex.

Circle 666 on Page 19

Instrument Gear Motor

has six repeatable speed ratios

Multispeed instrument transmission combined with a synchronous motor provides a gear motor with six positive, repeatable speed ratios which can be changed easily while the motor is running. Built to a standard NEMA Size 25 frame, gearhead can be adapted to any synchronous gear motor from 600 to 1 rpm. Speed ratios in standard mod-



els are 1, 2, 5, 10, 20, and 50:1. Standard units are built for 115-v, 60-cycle operation. Insco Co., Div., Barry Wright Corp., Groton, Mass.

Circle 667 on Page 19

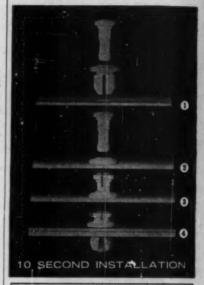
Relief Valves

in either low or high-pressure ranges

Externally adjustable relief valves permit precise control of pressures in hydraulic circuits. Available in cartridge-type construction or with an integral body, valves are available in either of two pressure ranges. Low-pressure models are

NYLATCH

LATCHES FOR INDUSTRY



- 1 PUNCH A STANDARD HOLE.
- 1 PUSH IN GROMMET CAPTIVATED!
- 1 PUSH IN PLUNGER CAPTIVATED!
- PUSH IN PLUNGER CAPTIVATED!
 PUSH TO LATCH PULL TO UNLATCH.

Nylatch is a positive interference type fastener . . . thoroughly tested for rugged, dependable service. It will not unfasten under the severest conditions of impact or vibration, yet may easily be opened and closed 30,000 times without appreciable loss of holding power.

Nylatch is being used to replace all manner of latches, captive screws, stud fasteners and spring clips.

Here are only a few of the hundreds of different uses for Nylatch: Electronic chassis; securing printed circuits; luggage; access doors; any type of removable panels; cabinets; neon signs; tool kits; and many more.

Perhaps one of these uses reminds you of an application that will help you cut costs.

Various head configurations are available; the easy-grip, the mini-grip and the tamper-proof shown above.

Write today for sample and literature:



THE HARTWELL CORPORATION 9035 VENICE BLVD., LOS ANGELES 34, CALIF.

BRANCH OFFICES: • CHICAGO • CLEVELAND • FORT WORTH • HACKENSACK • SEATTLE • WICHITA Where it's Gritty, Hot, or Corrosive, use



Grease Seals keep lubricant in . . . keep out dirt, dust, sand, steam, etc.

Faultless L900GS Grease Sealed Casters are designed to keep rolling, with minimum maintenance, in working areas where gritty particles, or harsh chemicals would damage ordinary casters. Neoprene Grease Seal and Grease Retaining Cup around Double Ball Bearing Swivel, plus Neoprene Ring around wheel bearing, give positive protection against materials that would clog caster movement, cause friction and wear. Companion L9700GS Rigid Grease Sealed Caster is available with matching specifications and sizes.

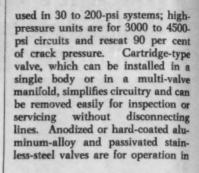


Your Faultless Industrial Distributor, or nearby Faultless Sales Engineer can supply you with detailed information on the L900GS, as well as the other casters in the complete, quality-tested Faultless Caster line. Also, your Faultless Distributor stocks casters at his warehouse for immediate shipment.

Faultless Caster Corporation Evansville 7, Indiana

Branch Offices in principal cities; see the Yellow Pages of the telephone book under "Casters." Canada: Stratford, Ontario.

Faultless Casters





temperatures from -35 to +275 F. Low-pressure model is 5½ in. long over-all, 3 in. high, and 2½ in. wide. High-pressure unit measures approximately 5½ by 2½ by 2 in. Fluid Regulators Corp., 313 Gillette St., Painesville, Ohio.

Circle 668 on Page 19

Small Motors

are rated 1/3 and 1/4 hp at 2750 rpm

Two motors are designed for OEM use on electric lawn mowers, golf-bag carts, and similar low-voltage, battery-operated equipment. Ratings offered are 1/3 and ½ hp at 2750 rpm. Using 12-v current, motors operate at efficiencies over 65 per cent. End-to-end ventilation assures proper cooling effect over entire length of motor. Lightweight, die-cast aluminum housings result in weight less than 11.5 lb; over-all length of the units, less shaft, is under 7 in. Mounting-face





diameter is 4.75 in. with four ½-20 drilled and tapped holes for mounting on 3.75-in. bolt circle. Shaft diameters of ½ and ½ in. are available. Small Motors Div., Robbins & Myers Inc., Springfield, Ohio.

Circle 669 on Page 19

Limit Switches

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ve

or

two-pole units control up to four circuits

Type AW obtight limit switches are now available with two-pole, double-throw snap switch which can eliminate the need for a second limit switch or control relay. Switch can control up to four circuits, and mounts interchangeably with other Type AW limit switches. Switches are offered with a selection of operators in a variety of lengths and designs. Both flush and surface-



mounting devices are available. Square D Co., Dept. SA, 4041 N. Richards St., Milwaukee 12, Wis.

Circle 670 on Page 19

Hydraulic Pump

of axial-piston type

WO7 variable-displacement hydraulic pump can be adapted to a variety of applications in a wide range of equipment. Nominal output rating is 9 gpm at 3600 rpm continuous, at 3000 psi. Speed range is 450 to 4500 rpm. Nonrotatable, hydrostatically balanced cylinder block has seven pumping pistons driven by fixed-angle rotating cam and wobble-type reaction plate. Self-aligning connecting rods and face-sealed reaction pistons eliminate side loads on cylinder

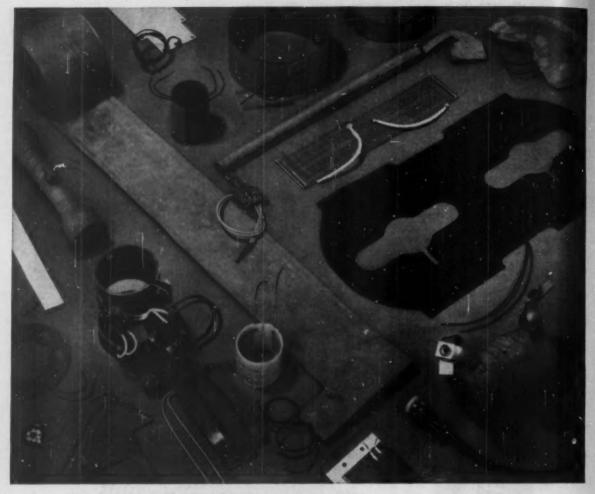


... IT'S HIDING BEHIND THE ASPIRIN. Actually, we set out to build an easy-to-read tiny timer...but we first had to build an aspirin-sized motor to drive it. This assignment might have been a headache for a sorcerer, but A. W. Haydon did it. And there is something magical about these microminiature elapsed time indicators and companion events counters. . This digital elapsed time indicator has many outstanding features: size is only 1/2" square x 11/4" long...weight .75 ounce...



meets all mil specs...temp. range -54 to +125°C...vibration to 2000 cps at 20 G ... choice of two ranges (hours to 9999, tenths to 999.9)... power input .5 watt, max. In fact, the complete data outweighs the equipment. Send for our heavyweight literature on the 19200 ETI right now. ■ Electrical or electronic. the A. W. Haydon Company works wonders in time. For electronic requirements call Culver City. For electromechanical devices call on our wizards in Waterbury.





Why do design engineers bring their defrosting, de-icing and heating problems to SAFEWAY?

The photo above provides a pretty good answer. SAFEWAY designs, engineers and manufactures just about every conceivable type of controlled-heat product you can think of. APPLICATIONS? From air conditioning units—to ground support equipment—to rockets—and scores of "in-betweens". CONSTRUCTION? Heating elements or blankets; woven or strung; laminated, molded and bonded to metals and plastics or both. Corrosion resistant, immersible. SIZE? Large, small, thick or thin. INSULATIONS? Silicone rubber, epoxy resin, neoprene, fiberglas, butyl, to name a few. SERVICE? All the way from one source—from engineering recommendations to the completed unit—produced on time in our modern manufacturing facilities. Write or call us on your problem. Our years of industrial and military experience are at your disposal.



Write today for our fact-filled brochure, describing the wide range of materials, specifications and application possibilities. Safeway engineers will gladly analyze your requirements and submit practical recommendations.



Middleffeld Street + Middlefown, Connecticut



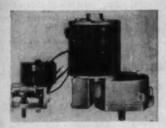
bores. Four control options are available. Unit is 95% in. long and has a maximum diameter of 51% in.; weight is 14 lb. Weatherhead Co., 300 E. 131st St., Cleveland 8, Ohio.

Circle 671 on Page 19

Goar Motors, Gear Boxes

have ratios from 4:1 to over 100,000:1

Sub'ractional-hp gear motors and gear boxes for original equipment are available with right-angle reduction gears. Single, double, and triple reductions can be made; ratios range from approximately 4:1 to over 100,000:1. Permanently sealed, conventionally closed, or skeleton units can be designed for each application. Precision-machined housings are made from castings, extrusions, and stampings. Typical applications include office machines, appliances, vending ma-



chines, coin-operated record players, and power-adjusted hospital beds. Spiroid Div., Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.

Circle 672 on Page 19

Cable Connector

connects flat cable to round wire

Adapter device for interconnecting flat conductor cable with conventional round wire is now available in the Pos-E-Flex line. Adapter



SHOCK AND VIBRATION PROBLEMS?

CONTACT THE SPECIALISTS:

BARRYCONTROLS

Division of Barry Wright Corporation

700 PLEASANT ST., WATERTOWN 72, MASS. 1400 FLOWER ST., GLENDALE, GALIF.

Nothing to Sneeze at!



SPENCER VACUUM

In equipment like these tablet forming machines, dust and spillage are more than just a nose-tickling nuisance. Unless controlled, dust can cause costly maintenance problems and can seriously hinder production.

Here, incorporation of a Spencer vacuum unit permits immediate pick up of the puff of dust which develops each time a tablet is pressed. This sensible arrangement has several advantages:

- "Down time" is reduced because dust doesn't work into moving parts.
- Health hazards are diminished.
- Production is speeded because less "clean up" is required.
- General working conditions are improved.

Perhaps a Spencer vacuum unit can improve the design of your product. For a no-obligation analysis and suggestions, write outlining your problem.

Tantin

REQUEST CATALOG NO. 155B, "SPENCER VACUUM".





simplifies the introduction of flat cable to existing electrical and electronic equipment wiring systems. It is used to terminate flat-cable runs at conventional terminal boards or strips, and facilitates flat-cable runs where the ultimate termination is to round wire. Thomas & Betts Co., 36 Butler St., Elizabeth, N. J.

Circle 673 on Page 19

Nylon Pressure Tubing

for temperatures from -40 to +185 F

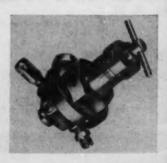
No. 9056 nylon pressure tubing is a light, strong flexible tubing which withstands high pressures and is easily installed. Flexibility eliminates prebending and the need for flexible couplings or intermediate fittings. Tubing resists fatigue, abrasion, impact, and most corrosive agents, and withstands temperatures from -40 to +185 F. It is available in sizes from ½ to ½ in. for hydraulic, lubricating, pneumatic, vacuum, air, chemical-processing, and caustic and dilute-acid lines. Garlock Inc., Palmyra, N. Y.

Circle 674 on Page 19

Gageless Regulator

in single or double-stage units

All-metal, gageless regulator is available for use with most pressurized liquids and gases. Furnished in single and double-stage models, regulators are less susceptible to



damage from blows or falls than glass-faced units. Bonnet and body are solid forged brass. Individually calibrated adjustment scales are etched on the bonnet for permanent, easy reading. Turn of the T-handle on the micrometer-type pressure-regulator cap sets and maintains desired working pressure. Tank pressure is shown by a positive-reading indicator rod which slides inside a hex plug. Dockson Corp., 3839 Wabash, Detroit 8, Mich.

Circle 675 on Page 19

Feed-Through Capacitors

miniature units have low inductance

ns

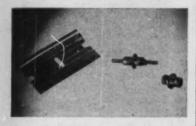
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Two eyelet feed-through capacitors feature an integral solder form for mounting. Because of their design and miniature size, both units provide excellent bypass performance where space is a critical factor. Low inductance characteristics make them



suitable for high-frequency bypass. Type 7427 has a center lead; type 7528 has no lead. Both types have a capacity of 1000 mmf with a 500 dc working voltage. Hi-Q Div., Aerovox Corp., Myrtle Beach, S. C. Circle 676 on Page 19

Miniature Clutches

operate to 1800 rpm without lubrication

Miniature clutches transmit up to 10 lb-in. of torque for coupling or through-shaft applications. Oilimpregnated, sintered-alloy construction permits operation to 1800 rpm without lubrication; units can run at higher speeds when lubricated. Two types are available: Coupling type is used for connecting two separate shafts, and through-shaft design permits any combination of gear, pulley, or cam input-or-output combinations. Both types are also available in three

the NEG'ATOR



Using NEG'ATOR springs to produce constant torque



1. The NEG'ATOR spring is a strip of spring steel formed into a prestressed coil. It resists uncoiling with a uniform pull—provides a truly constant-force spring of practically any length.



 By reverse winding the free end around a second, larger drum, we can utilize the tendency of the material to recurl to its preset curvature to make a powerful, longrunning NEC'ATOR motor.



2. Thus, the NEG'ATOR motor releases maximum useful energy at constant-torque output from full wind to run down. Associated components can be greatly simplified because there is no exaggerated torque peak.



4. In counterbalancing, very long vertical travel is possible from a compact NEGATOR unit concealed overhead, or even in the moving unit.



 Reeling in long cords or retracting cable-connected loads is another NEG'ATOR function made possible by its great length, smooth action and constant-force properties.



6. As an anti-backlash device, a NEG'ATOR motor ensures immediate response without lag. Constanttorque load can be applied over slight movement or over many, many turns.

7. Six stocked models of NEG'-ATOR motors are available to designers for test or assembly purposes. These models provide cable tensions of %, 1, 2, 3, 4 and 5 lbs.



How to use NEG'ATOR Motors?

■ Movie cameras, valve operators, recording instruments, satellite recorders, timers, X-ray apparatus, lighting fixtures, appliance cord retrievers, and other familiar products use NEG'ATOR motors, reels and counterbalances.

Write for details.

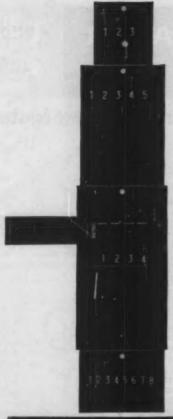
The NEG'ATOR spring is a development of Hunter Spring Company.

HUNTER SPRING COMPANY A Division of American Machine and Metals, Inc.



A Division of American Machine and Metals, Inc.
3 Spring Avenue, Lansdale, Pennsylvania
ULysses 5-6815 TWX: 982-U

DIVISIONS OF AMERICAN MACHINE AND METALS, INC.: Troy Loudry Machinery Richie Testing Rachines - De Bothezat Fans - Tolhurst Centrifugals - Filtration Engineers - Filtration Fabrics Niagara Filters - United States Gauge - Rehm Instruments - Lamb Electric Co. - Number Spring Co. - Gisser-Stoers Corp.



SODECO

TCe SERIES COUNTERS

Quality where it Counts!

The TCe line of Sodeco electric impulse counters offers the maximum in readability, counting accuracy and reliability with a minimum panel space requirement, power demand, and cost. In this broad line you'll find a counter for your every counting application. Pictured here are representative counters in this series. Starting at the top:—

A. Three Digit Manual Reset — Type TCeZ3E—also available with 4, 5 or 6 digits—speeds of 10-25 or 50 imp/sec. Single-stroke toggle reset, Low Cost. Compact.

B. Electric Reset — Type TCeF5E — Available also with 4 or 6 digits—single pulse resets all figures to zero. Speeds up to 50 imp/sec. C. Predetermining Counter—Type TCeZ4PE—Available with manual or electric reset. Double-throw switch actuated at zero. Electric-reset models available with built-in rectifier for AC operation.

D. Eight Digit Totalizer (No Reset; — Type TCe8E — also available in seven digit model. Low power requirement, Compact. Economical.

You can get amazing versatility from your Sodeco TCe Counter. Most counters have provision for reset, periodical and armature contacts which permit a control function to be added to the normal counting operation. Special counters tailored to your individual applications can be supplied. Write for complete information and recommendations.

GYR, INC. 45 West 45th Street New York 36, N. Y.



types of drive: Single revolution which permits stopping the output hub at exactly the same place when driven by a continuously rotating input shaft; start-stop model, which permits engaging and disengaging the clutch from a continuously rotating shaft; and the over-running type which transmits torque in only one direction, and acts as a free-wheeling device. Precision Specialties Inc., Pitman, N. J.

Circle 677 on Page 19

Casting Resin

is self-extinguishing, two-part formulation

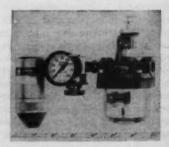
Stycast 1223 is a general-purpose casting resin which flows readily and is self-extinguishing. It has a dielectric constant to 10 kmc of 4.1, and dissipation factor to 100 mc of 0.01. Chemical resistance is retained, and machinability is excellent. Product is supplied as a two-part formulation with a pot life of ½ hr at 175 F. It has 3:1 weight ratio of resin to catalyst. Emerson & Cuming Inc., Canton, Mass.

Circle 678 on Page 19

Compressed-Air Unit

is 7 in. long, 43/4 in. high

Combomatic filters, regulates, and lubricates compressed air in one package unit. It is 7 in. long and $4\frac{3}{4}$ in. high, and weighs $2\frac{1}{2}$ lb. Unit incorporates an automatic drain trap on the filter, prohibiting moisture from accumulating in the sump



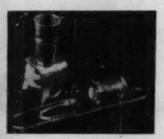
of the filter. Filter is all-aluminum with Buna-N seals. Model 64240-2 has a capacity of 12 cfm at 100-psi air pressure, and is available from stock in ½-in. P.T. It is used on air valves and cylinders, small air tools, die grinders, and small air motors. Wilkerson Corp., 1646 W. Mansfield, Englewood, Colo.

Circle 679 on Page 19

Midget Lampholder

for use with midget-groove lamp

Series WE 700 midget-groove lampholder provides for use in small space. Lampholder, together with T/TL 1¾ midget-groove lamp, has mounting brackets which allow for panel mounting on ¼-in. centers. Lamp is held securely in a nontilt position and is vibrationproof. Lampholder is furnished with a



standard 6-in. length of PVC wire; housing is 0.010-in. annealed spring steel, hardened, tempered, and cadmium plated. Variety of standard mounting brackets, including panel-mounting brackets, is available, together with plastic lens caps of all colors. Webster Electronics Co. Inc., 237 Lafayette St., New York 12, N. Y.

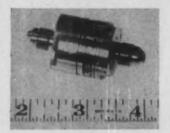
Circle 680 on Page 19

Stainless-Steel Filters

provide high filtration area

Small lightweight, stainless - steel filters have filter elements of Rigimesh, a sintered woven-wire mesh which is corrugated to provide maximum area. Filter medium also assures positive control of pore size regardless of system shock or vibration. Filters are 2 in. long, including connections, and have 1-in. diam; weight is $2\frac{1}{2}$ oz. Units handle hy-





draulic fluids, lubricating oils, fuels, gases, and substances such as red fuming nitric acid, in temperatures from -320 to +450 F and working pressures to 5000 psi. Removal ratings vary from 15 microns absolute to 450 microns. Filter media for the 15-micron absolute units are Supramesh. Pall Corp., 30 Sea Cliff Ave., Glen Cove, N. Y.

Circle 681 on Page 19

Stainless-Steel Alloy

for severe coldforming applications

Armco 18-9 LW is a low hardening, stainless-steel alloy developed for

severe cold heading, swaging, and other cold-forming applications. Material offers fabricating properties and corrosion resistance similar to that of 16-8 stainless and other highnickel alloys at a price equal to that of Type 305 stainless. It can be used for fasteners and related parts in automotive, aircraft, missile, chemical equipment, and appliance applications where corrosion resistance is important. Machinability approaches that of free-machining grades. Alloy is available in billets, hot and cold-finished bars, hot-rolled rods, and cold-drawn wire. Armco Steel Corp., Middletown,

Circle 682 on Page 19

Epoxy Resin

is self-extinguishing in less than I sec

Low-viscosity, flame-retardant resin system, Isochemrez FR, handles like conventional resin and can be supplied filled or unfilled. It is available for applications requiring self-extinguishing properties. Wide

variety of fillers, hardeners, and colors is furnished. Isochem Resins Co., 221 Oak St., Providence 9, R. I.

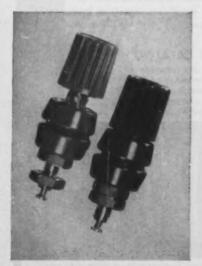
Subfractional-HP Motors

are explosionproof units

New explosionproof, subfractional-horsepower motors are available in one, two, or three-phase induction or synchronous types from 1/150 to 1/20 hp. Two, four, and eightpole models give synchronous speeds of 3600, 1800, and 900 rpm. Standard mounting is flange or foot; others are available on special order. Motors are approved by UL for operation in Class I, Group D, and Class II, Groups F and G en-



G-E LEXAN® POLYCARB



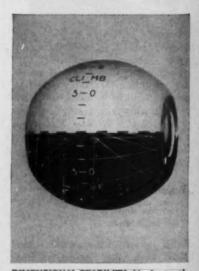
STABLE ELECTRICALS. Binding posts made of LEXAN resin retain electricals even under moist, hot conditions. They do not loosen, are molded in six attractive LEXAN colors for coding. Other features are: low loss and power factor, low dielectric constant, high voltage insulation, non-sink surfaces.

(Superior Electric)



HEAT RESISTANCE. Beautiful handles of LEXAN polycarbonate resin are used in rugged service on U.L. approved soldering irons. They resist the impact, heat and abrasion of daily bench work. The hard, glossy handles are light in weight. Molded in three pastel colors, they provide toughness and sales appeal.

(Ungar Electric Tools)



DIMENSIONAL STABILITY. Maximum allowable change in this 5-inch aircraft instrument part is only 5 mils over a temperature range of -65° to 300°Fl And it must maintain this tolerance under high humidity. Part is injection moided of LEXAN resin as half spheres which are solvent cemented, latheturned and painted. (Lear, Inc.)

vironments. Holtzer-Cabot Motor Div., National Pneumatic Co. Inc., 125 Amory St., Boston 19, Mass.

Circle 684 on Page 19

Stack Switch

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for miniature electronic equipment



Tini-Stack, 1¾ in. long, consists of a "pile-up" of various miniature springs and insulators, with maximum length of contact spring 1¾ in., 3/16 in. mounting centers, and 5/32-in. wide switch parts. Because of its miniature size, switch can be wilized in compact electronic equipment. Springs are tempered nickel-silver in most standard thicknesses from 0.006 to 0.016 in. Spacers are Type XXXP paper-base phenolic, in thicknesses of 1/64, 1/32, and

3/64 in. Welded contacts of fine silver or cross-bar Palladium are rated at 3 amp, 300 w, ac noninductive load. Switchcraft Inc., 5555 N. Elston Ave., Chicago 30, Ill.

Circle 685 on Page 19

High-Strength Epoxy Adhesive

is two-component system mixed in equal parts

Bondmaster M666 is a two-component, room-temperature-c u r i n g, epoxy adhesive formulated for highstrength industrial use. It is mixed in equal parts by volume instead of odd ratios by weight. One part is cherry red and the other clear amber; they are mixed until a uniform tint is achieved. Mixed adhesive is smoothly free-flowing, can be applied with spatula, trowel, paint roller, knife, brush, or twopart epoxy spray equipment. Red color provides swift visual check on uniformity of coverage. Fully cured metal-to-metal bonds produced, tested at room temperature using MIL-A-5090B procedures, yielded up to 3500 psi. Bonds involving expanded styrene foam withstand

175 F for 200 hr without cell attack. Rubber & Asbestos Corp., Dept. P, 225 Belleville Ave., Bloomfield, N. J.

Circle 686 on Page 19

Gear Reducer

changes speeds while rotating

Multi-Speed, direct-coupled gear reducer, available in several sizes to suit torque requirements, changes speeds while rotating. Unit has applications in power transmissions for industrial process controls and instrumentation of computers, data-reduction equipment, and film and tape-drive mechanisms. Standard



ONATE RESIN GOOD DIELECTRIC-



TRANSPARENCY of LEXAN resin is important in chart guide for recorder. LEXAN resin is the only transparent plastic able to withstand heat generated by internal lights. It is distortion-free at temperatures up to 270°F and self-extinguishing. Its extremely high impact strength eliminates cracking of guides. (The Foxboro Co.)



TOUGHNESS. Press-fitted into metal gear used in an electric drill, bushing of LEXAN polycarbonate resin provides safety from electric shock. helps eliminate need for additional grounding. Strength and creep resistance of LEXAN resin enables bushing to withstand torque and load requirements of drill. (Millers Falls Co.)

ARE YOU LOOKING FOR A PLASTIC THAT CAN REALLY TAKE IT?

To demonstrate the toughness of LEXAN resin, salesmen will sometimes slam and hammer a product made of the material. LEXAN has the highest impact strength of any plastic — amounting to 12-16 footpounds per inch of notch — and it usually emerges unscathed from encounters with such "merchandising stresses". It is a high-performance material, likewise, with regard to high-temperature behavior and dimensional stability.

Its many other advantages make it a priority material for thorough investigation by all designers, engineers and molders. We will be pleased to supply you with information on the properties, processing and end-uses of LEXAN resin. Don't hesitate to write to us. General Electric, Chemical Materials Department, Section MD-101, Pittsfield, Mass.

LEXAN*
Polycarbonate Resin

GENERAL 🌑 ELECTRIC



looking for better than jewelry quality in precious metal tubing?

If you are a nuclear or electronics engineer looking for a supply of jewelry quality small tubing in silver, gold, palladium or their alloys, here's good news! The quality tubing you seek is available from Uniform Tubes with O.D.'s from 0.005" to $\frac{3}{3}$ ". What's more, you can order this tubing precision drawn to any wall thickness from 0.035" down 50 0.001" within tolerances of ± 0.0005 "... ± 0.00025 " on the smallest sizes!

UNIFORM cuts this tubing to specified lengths with ends square and free of burrs. UNIFORM's experience in working precious metals is also available for the fabrication of tubular parts. Flaring, coining, bending and other fabricating steps are completed with the same precision and skill applied to drawing the precious metal tubing.

Where the corrosion resistance or apecial properties of a precious metal are needed on either O.D. or I.D. only, UNIFORM supplies COMPOSITE TUBING with the precious metal drawn over a precision tube of a less expensive base metal or vice versa.

Composite tubing meets the same close tolerances and quality standards UNIFORM sets for tubing of silver, gold, palladium or their alloys.

Phone, wire or write today for details and a quotation. Delivery is normally less than three weeks.



units are available from stock in six input-output ratios. Analog General Corp., 7-11 Main St., East Rockaway, L. I., N. Y.

Circle 687 on Page 19

Miniature Solenoid Valve

for operating pressures to 3000 psi

Miniature, two-way, normally closed, solenoid shut-off valve has direct actuation, operating pressures to 3000 psi, 1/16-in. diam orifice, explosion-proof case, and bubble-tight sealing characteristics. Series 600 valve is available with nylon or Kel-F poppets to insure bubble-



tight sealing, even with corrosive fluids. The 1/16 in. orifice permits high flow rates with low pressure drop. Low amperage, long-life coil is rated for continuous duty with either ac or dc voltages and operates at temperatures from -40 to 160 F. Circle Seal Products Co. Inc., 2181 Foothill Blvd., Pasadena, Calif.

Circle 688 on Page 19

Magnetic-Hold Switch

permits electrical release from a remote location

Magswitch is a small, magnetic hold-in switch with a built-in solenoid which permits electrical release from a remote location. When toggle lever is operated and solenoid energized, lever stays in the actuated position until it is released manually or electrically by de-energizing the solenoid. Slender, 1-in. diam housing makes the switch ideal for locations where space is limited. Enclosure is filled with an inert gas under pressure to assure constant op-



ASSISTANCE QUALITY PRODUCTS EXCELLENT SERVICE

YOUR INQUIRY INVITED . . . CATALOG SENT UPON REQUEST

ELECTRIC WHEEL CO.

Division of the Firestone Tire & Rubber Company Dept. WH-5

QUINCY 6, ILLINOIS



erating characteristics, regardless of atmospheric pressure variations. Turret-type terminals are furnished for easy solder connections. Electrical rating of the DPDT switch is 28 v dc at 24 amp inrush; 4 amp resistive; 2.5 amp sea level (sealed) and 2.0 amp at 65,000 feet (unsealed) inductive; 4-amp motor. Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle 689 on Page 19

Line Strainers

for 600 psi at 650 F or 1000 psi at 100 F

Ductile-iron line strainers are available from stock in ½ to 3-in. sizes with screwed ends. They are suitable for 600 psi at 650 F or 1000 psi at 100 F, for steam, water, air, oil, gas, or chemicals. The 801J series strainers have 30-mesh Monel screen as standard, with other mesh or perforations and metals avail-



able as required. OPW-Jordan, 6013 Wiehe Rd., Cincinnati 37, Ohio.

Circle 690 on Page 19

Subminiature Fuse

is suitable for printed circuits

Subminiature Microfuse has a diameter of 13/64 in. and length of 11/32 in. It features low resistance



Eliminate special sizes...fit more accurately!

S. S. White General Purpose "GP" Plastic Protectors are an improved way to protect your products during manufacturing, shipping and storage.

Each GP protector can be used as either a cap or a plug on all machine screw threads, pipe threads, and tubing in a range from ¼" to 2¼"... with an accurate, engineered fit. GP protectors eliminate special sizes and fit better!

"GP" protectors are made of a special grade of elastic polyethylene that cushions shock and is unaffected by oils, greases, acids and other common solvents. They have a "stay-put" fit, yet they are easy to grip for a quick, non-shredding removal.

Start now to put an end to customer complaints about damaged equipment. Use low cost GP protectors!

WRITE FOR BULLETIN 6104-GP

Complete details

Asthite PLASTICS

Dept. 49, 10 East 40th Street, New York 16, N. Y



Compare Index Units! FERGUSON "PROVES OUT" ... Point by Point.

Selection of components for a production machine should be based upon the machine's return per dollar investment. Matching "first costs" only does not generally result in the design of profitably operated equipment.

Here is a check list for comparison of indexing mechanisms. "Price" is shown in its order of consideration.

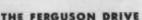
1. BACKLASH-None? Some during the dwell or index or both? Any backlash during any part of the cycle results in wear-causing vibrations and shock loads . . . The Ferguson Drive maintains zero backlash at all times

2. RATED LOADS-What is the rated life and under what load? What is the average follower life (B-10 life)? The Ferguson Drive is rated at maximum precision for at least 8,000 hours operation and with an average follower life of 90%. Replacement of the followers renews the life of the Drive for another 8,000 hours. Ferguson cams never wear out under rated loads.

3. JOB SUITABILITY-Can the acceleration characteristic be preselected according to job requirements or is it inherent in the mechanism or limited by the manufacturer? Acceleration of the Ferguson Drive can be chosen after an application evaluation to provide optimum operation.

4. INDEXING ACCURACY—Are time-consuming shot pins necessary for precision?... They soon wear and lose accuracy. The Ferguson Drive is positive locking and locating for extreme precision without shot pins.

5. FIRST COST vs. TOTAL COST -Now consider the higher production rates, better quality and much lower maintenance costs the Ferguson Drive gives you. Determine the total cost of the various indexing mechanisms. The Ferguson Drive has proved out . . . And you're on the way to building more profitable production equipment.





Cam features a tapered rib along which two standard cylindrical followers roll without clearance . . . maintaining zero backlash during index and dwell. While in the dwell or "work" position a straight portion of the cam rib locks the hub positively, without auxiliary locating or locking devices. Extreme precision is inherent, even at speeds as high as 2,000 indexes a minute!

CATALOG NO. 161 gives complete design data on nearly 100 standard indexing mechanisms, over 150 index one for every design engineer.

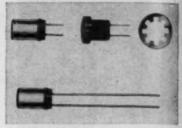
tables and various auxiliary items. Send for your free copy . . . There's



FERGUSON MACHINE COMPANY

A Division of Universal Match Corporation 7818 Maplewood Court

St. Louis 17, Missouri



and high reliability in fast blowing characteristics. Unit has a shortcircuit interrupting capacity of 125 v, 10,000 amp dc. Fuse is available in pigtail and plug-in varieties. Fuse holder allows fast replacement, handles continuous currents to 5 amp at 125 v or less. Fuse holder is mounted by a spring nut. Littlefuse Inc., 1865 Miner St., Des Plaines, Ill.

Circle 691 on Page 19

Pressure-Sensitive Tape

of polyvinyl fluoride has good electrical properties

Temp-R-Tape PVF consists of Tedlar polyvinyl-fluoride film with a pressure-sensitive, silicone-polymer adhesive on one side. Tape offers good weatherability, toughness, chemical resistance, and electrical properties. It has many uses in the electrical and construction fields, as well as throughout industry as a protective covering, release surface, and electrical insulation. Samples are available for evaluation in 1-in. by 5 yd rolls. Connecticut Hard Rubber Co., 407 East St., New Haven, Conn.

Circle 692 on Page 19

Hysteresis Clutch

is fractional-horsepower unit

New hysteresis clutch delivers controllable torque through a range of speeds and loads. It is capable of synchronous driving, or continuous slip, with negligible torque variation at any slip differential. Unit



has output torque proportional to a de-control current. There is no mechanical connection between input and output shafts except shaftsupport bearing. Unit shown is rated 1/20 hp at 1800 rpm, measures 21/2 OD, and is applicable to business machines, tape-tensioning devices, recorders, and servo-control systems. Scanner Corp. of America, 30595 W. Eight Mile Rd., Livonia, Mich.

Circle 693 on Page 19

Air-Control Valve

for double-acting. 2-in. diam cylinders

New 1/8-in., four-way air-control valve, bleeder-poppet operated, is machined from solid aluminum and has Teflon slides, requiring no lu-



brication. It is recommended for double-acting cylinders to 2-in, diam. Novi-Matic Valve Div., Novi Tool & Machine Co., 25806 Novi Rd., Novi, Mich.

Circle 694 on Page 19

Time-Delay Control

develops de voltage from signals of any wave length

Thermo-Electric time-delay control operates automatically and eliminates many components required by such devices. It has applications in magnetic-amplifier circuits, and is suitable for use in conjunction with flip-flop gating circuits as used in electronic computers and analyzers, missile controls, and other applications subject to wide and varying changes in tempera-Control develops pure dc voltage from signals of any wave length applied to it. It is independent of ambient temperatures to 350 F, and is also unaffected by external radiation and random noise. Unit is mounted in potted-epoxy



troublesome. Thousands of progressive engineers and designers have solved this problem by application of BALL BUSH-INGS on guide rods, reciprocating shafts, push-pull actions, or for support of any mechanism that is moved or shifted in a straight line.

Improve your product! Up-date your design and performance with Thomson BALL BUSHINGS!

Sliding linear motions are nearly always LOW FRICTION . ZERO SHAKE OR PLA **ELIMINATE BINDING AND CHATTER** SOLVE SLIDING LUBRICATION PROBLEM LONG LIFE - LASTING ALIGNMENT

> The various types cover a shaft diameter range of 1/6" to 4". Small sizes available in Stainless Steel. Write for literature and name of our representative in your city.

THOMSON INDUSTRIES, Inc.

Dept. E, MANHASSET, NEW YORK

Circle 378 on Page 19

Also Manufacturers of NYLINED Bearings: Sleeve Bearing of DuPont Nylon, and 60 CASE... Hardened and Ground Steel Shafting



TAISAISTAN SANDAR

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FACTS OF INDUSTRIAL TOOL
USE AND MAINTENANCE

Hobbs Industrial Hour Meters provide continuous supervision of the running time of industrial machines . . . eliminating errors and deficiencies for maximum production. These elapsed time indicators tell when servicing is due . . . indicate the costs of running hour for both the machine and occupied space.

OBBS

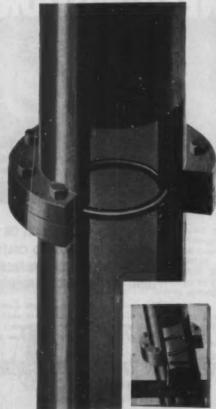
Hobbs Industrial Hour Meters make it easy to determine the life and repair costs per running hour of industrial machines . . the actual running time of leased equipment and equipment to be sold. They set up a sound basis for service contracts. For complete information . . .

WRITE FOR CATALOG 600 Distributors in Principal Cities

John W. Hobbs Corporation

A DIVISION OF STEWART-WARNER CORPORATION SPRINGFIELD, ILLINOIS

SPRINGFIELD, ILLING



POSITIVE SEALS

-452° to 3000° F.

United Self-Energized Metallic O-Rings*...

form permanent, non-corrosive, static seals under temperature extremes from -452° to 3000° F. and pressures from 10-4 mm Hg to 100,000 psi. Available in various metals and coatings (including Teflon** and silver) ½" O.D. dia. to any size and configuration. United also makes non-vented and pressure-filled O-rings. United Metallic "O" Rings, manufactured by United Aircraft Products, Inc., Box 1035, Dayton, Ohio.

See United Metallic O-Ring Catalog in Sweet's Product Design File or write for Free Handbook

°Patents 2,809,269; 2,837,360 °DuPont registered trademark



resin with protruding leads for connection purposes. Typical control, shown, is 2 in. long and 5/16 in. diam. Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 695 on Page 19

Teflon Felts

have good chemical resistance and high filtration efficiency

Teflon felts are available in widths to 72 in. and lengths to 60 yd. Felts are particularly suited for industrial applications where extreme conditions prevail, such as in filtration. They have excellent chemical resistance and resistance to temperatures from -100 to +400 F; under certain conditions they are useful to 600 F. Filtration efficiency is characterized by fine particle removal, high flow rates, and low pressure drops. Felts also have a low coefficient of friction, making them suitable for use in contact with moving parts, such as lowfriction cushioning pads. American Felt Co., 2 Glenville Rd., Glenville,

Circle 696 on Page 19

Dual-Purpose Gaskets

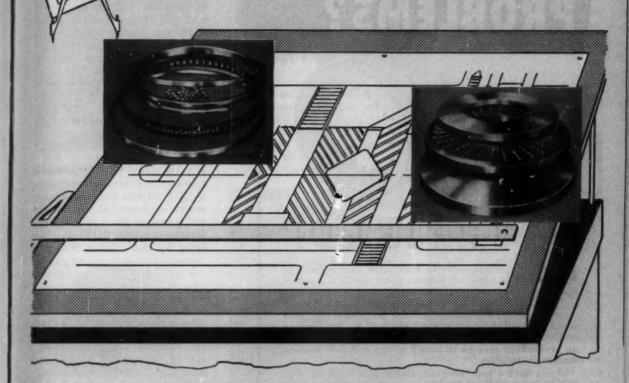
are RFI-shield and fluid-sealing units

Radio-frequency-interference shield and fluid-sealing gaskets are Duolastic wire screen impregnated with



Put MESSINGER BEARINGS

on the Drawing Board



When design calls for bearings, it will pay to have a Messinger engineer "sit in" at the earliest stage. The result is very likely to include simpler design, lower manufacturing costs and greater efficiency of the planned product or equipment.

Backed by nearly half a century of engineering experience, Messinger Bearings provide heavy capacities in smaller space and with less weight; assurance of long, trouble-free service life; and adaptability to the widest range of size and shape requirements.

Consultation Invited Without Obligation

Radial Roller Bearings—Plain and Self-Aligning. Thrust Roller Bearings—Plain and Self-Aligning—Single and Double Acting. Combination Radial and Thrust Roller Bearings. "X"Roller Bearings. "Featherweight" Ball Bearings.

lin. eer

MESSINGER



BEARINGS, Inc.

FEATHERWEIGHT TO HEAVYWEIGHT

D STREET ABOVE ERIE AVE. . PHILADELPHIA 24, PA.

"Smoothing Industry's Pathway for Nearly Half a Century"



CEAR PERFORMANCE to match the ever-increasing power and speed of modern machines is a Fairfield specialty. This is possible because Fairfield has long held a position of leadership in utilizing the most advanced methods, equipment, and techniques for producing better gears EFFICIENTLY, ECONOMICALLY. By keeping apace with modern engineering trends, Fairfield renders an invaluable service to many of the nation's leading machinery builders.

If you have a gear problem, check with Fairfield. Our engineers are well-qualified to give you expert recommendations. LARGE or SMALL, your requirements will receive prompt attention. CALL OR WRITE.

SPUR GEARS—Straight, helical, and internal. Sizes from 16 pitch, $1\frac{1}{2}$ " dia., to $1\frac{1}{2}$ pitch, 48" dia.

HERRINGBONE—(Fellows Type). Sizes from 11/2" to 34".

SPIRAL BEVEL-Sizes from 16 pitch. 11/2" dia., to 11/2 pitch, 28" dia.

STRAIGHT BEVEL—Sizes from 16 pitch,

11/2" dia., to 11/2 pitch, 28" dia.

MYPOID—Sizes from 11/2" to 28" dia

ZEROL—Sizes from 16 pitch, 11/2" dia., to 11/2 pitch, 21" dia.

WORMS AND WORM GEARS-Worms to 7" dia. Worm gears to 36" dia.

SPLINED SHAFTS - Lengths to 72".

DIFFERENTIALS — 3,000 to 750,000 inch pounds capacity.

pitch, 28" dia. GROUND TOOTH SPUR, HELICAL, om 1½" to 28" dia. AND SPIRAL BEVEL GEARS.

Note: All of the sizes above are approximate.



TRACTORS . HEAVY DUTY TRUCKS . AGRICULTURAL MACHINERY . POWER SHOVELS AND CRANES MINING MACHINES . ROAD GRADERS . BUSES . STREET SWEEPERS . INDUSTRIAL LIFT TRUCKS

fluid-sealing materials. Gaskets are 0.020-in. thick and can be cut to order in a variety of complex and intricate shapes, in almost any size desired. Aluminum-wire screen provides a radio-frequency interference shielding effectiveness of 75 to 100 db, with an insertion loss of 40 to 60 db. Neoprene or silicone impregnation provides pressure-tight fluid sealing in the gasketed joint. Technical Wire Products Inc., 129 Dermody St., Cranford, N. J.

Circle 697 on Page 19

Silicon Power Transistor

has current gain of 1000 at 2 amp

WX 118 silicon power transistor is a 10-amp unit with a current gain of 1000 at 2 amp and 0.35-ohm saturation resistance. Device has voltage ratings to 150 v and a power dissipation rating of 150 w. It is suited for application in high-pow-



er, high-efficiency regulators, and switching circuits. Unit can replace cascade arrangements of two or three transistors in many applications. Semiconductor Dept., Westinghouse Electric Co., Youngwood. Pa.

Circle 698 on Page 19

High-Current Switches

in precision, snap-acting design

Making and breaking 25 amp at 125 or 250 v ac, in SPDT circuits, Unimax 2HG precision snap-acting switches provide high current-handling capacity. Series is available in basic style with pin actuator, and with overtravel-plunger, leaf, leaf-roller, lever, and roller-lever actuators. It is furnished in three standard base styles. Molded phenolic case is 1 15/16-in. long, 11/16-in. wide, and 13/16-in. high. Mounting holes accept 0.139-in.

PRODUCT-DESIGN BRIEFS FROM DUREZ

- High-impact phenolics for shock environments
- Fast forming with thermosetting resins
- Fire retardance plus in structural plastic



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Better impact strength

The reverse clutch cone pictured here is molded of Durez 16771, a high-impact phenolic material made with fibrous glass. The cone does duty as a brake against which the steel ring gear of a planetary train is stopped while the transmission is under full power.

In this application, the part is buffeted by murderous static and dynamic friction, developed heat, and the 5000-lb. force of the actuating piston. It must also do battle with the chemical effect of transmission oil.

The test performance proved that the phenolic part does a better job than metal in all respects. You would therefore expect it to do equally well in other shock environments—and you'd be right. A few examples: stud-welding gun, rocket nozzle, compressor support, motor end-bell, washer sheave, missile nose cone.

Durez 16771 abounds in unique advantages, the most valuable of which is its refusal to warp or shrink. You can mold parts to exact dimensions, without needing to allow for shrinkage.

If you'd like a closer look at the properties and design advantages of high-impact phenolics, we'd like to send you a reprint of an article written for Product Engineering.

A resin that forgets

Forgetfulness is a virtue in this material.

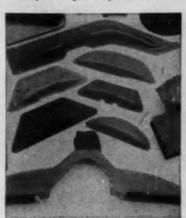
It is a prepreg, commonly called "forming board," made from kraft fibers in which Durez phenolic resin has been dispersed as binder. The producer of the prepreg, whose name we'll be glad to send you on request, supplies it in thicknesses ranging from .060 to

.150 inch, and in sheet sizes to 55 x 72 inches. A sheet can be stored two years at 70°F without losing its usefulness.

Squeezed at 300-500 psi in a hot press, the prepreg "sets" within 5 to 15 seconds to become a strong, rigid molded shape that will withstand moisture, heat and mild corrosives.

This is where forgetfulness comes in. There is no springback or "memory" effect in this forming board, because as it cures the resin changes its chemical nature to become a different substance, one of great durability.

As you might suspect, there are



many other uses for Durez thermosetting resins of interest to almost anyone developing new products. To get a better idea of how their interesting properties might help you, check the coupon for Bulletin D102, a 12-page idea book.

Delight for designers

Structural paneling which incorporates Hetron® polyester resin in its manufacture is proving a boon to designers concerned with safety and strength... a delight to decorators seeking the attractions of color and translucence.

Hetron paneling is fire-retardant. It does not sustain combustion. It offers the added benefits of light weight, un-



breakability, resistance to corrosion and to climatic extremes. It has high strength-to-weight ratio, excellent impact strength and finishing properties.

Other applications of Hetron range from auto fenders to portable hangars for jet aircraft. To enrich your knowledge of this versatile material, we'll gladly send you our Designer's Data File and the names of fabricators.

For more information on Durez materials mentioned above, check here:

- ☐ High-impact phenolic molding material (reprint of article)
- ☐ Thermosetting resins (12-page Bulletin D102)
- ☐ Hetron fire-retardant polyester resin (data file and fabricator list)

Check, clip and mail to us with your name, title, company address.

DUREZ PLASTICS DIVISION

5 1 0 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION







- Safely limits torque
- Protects against overload-jams - downtime
- Resumes drive automatically after overload
- Eliminates shear pins and lost time
- Adjustable-while-running feature available

"Value is related to function-not to cost."

Hilliard Slip Clutches give you continuous, positive, and reliable protection of drives on packaging machines . . . case loaders . . . conveyors . . . dishwashing machines . . . printing presses . . . circuit breakers . . . and many others.

They also maintain steady torque while permitting speed variation on fabric drying drums, steel strip slitters and similar equipment.

Adjustable-while-running types maintain constant tension on rewind stands for paper coaters, textile machines, rope, steel and wire mills and for drive systems requiring overload protection but which must be disconnected at times.

Write for Bulletin 300 for complete details.

Remember, HILLIARD is your Industrial Clutch specialist . . . for more than 55 years . . . and the line includes Over-Running Clutches. Intermittent Drive Units, Single Revolution Clutches, Hilliard-Twiflex Centrifugal Coupling.



CASE LOADERS



CONVEYORS



DISHWASHING



Manufacturing Clutches for over 50 years

THE HILLIARD CORPORATION

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ELMIRA, N. Y.

IN CANADA: UPTON . BRADEEN . JAMES, LTD.

NEW PARTS AND MATERIALS



diam pins or screws on 1-in. centers. Unimax Switch Div., Maxson Electronics Corp., Ives Rd., Wallingford, Conn.

Circle 699 on Page 19

Self-Aligning Bearing

is now available in three-bolt type

Three-bolt flange-mounting, selfaligning bearing has been added to the Lube-Align bearing line. Bearing consists of a one-piece, integrally cast, spherical, self-lubricating bronze bearing nested in an aluminum housing. It provides an increased supply of oil and eliminates the necessity for oil cups or grease



fittings. Bronze Bearings Inc., 3553 Addison St., Chicago 18, Ill. Circle 700 on Page 19

Conveyor Belting

handles bulky, hot, or heavy materials

Flat-top, hinged-steel conveyor belting and flat-top belt conveyors incorporate end-curved, interlocking, overlapping steel belt links, precision formed to provide an almost smoothtop carrying surface. Through shafts, at each pitch, extend to join the sidedrive chains and position them. Intermediate connectors are used to fit over the through shafts. Attached to the underside of the belt, they tie the entire assembly into an integral rigid unit that is easy to assemble and disassemble. Conveyors transA NEW ADDITION TO THE

SONAC LINE

POSITIVE

ULTRASONIC

LEVEL

CONTROL

The components of Sonac (sensor actual Size)

Now, two new ultrasonic sensors, especially for level control have been added to the Delavan line of sonac sensing and switching devices.

The single sensor system is recommended for liquid level control and the double sensor system for dry level control.

Control is maintained by installing the sonac sensor through the wall of the vat, bin or hopper. When the oscillation on the face of the sensor is dampened or impeded by the material being sensed, the signal to the control unit changes, activating a relay.



FIG. 1-LIQUID LEVEL (One Sensor)



FIG. 2-DRY LEVEL (Two Sensors)

For level control, sonac is accurate to .005" and has a response time of 25 milliseconds. Performance of the sensor does not deteriorate with age.

The level control uses to which sonac can be applied are virtually unlimited. It is not affected by the viscosity*, specific gravity, conductivity, or capacitance of the material being sensed. Temperature or pressure changes of the material do not alter its performance. False signals are eliminated because sonac may be adjusted so as not to sense steam, foam, or vapors.

*Viscosity may affect response time.

Canadian Representative:

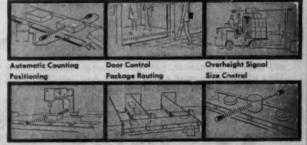
KNOWLES & FOSTER (North America) Ltd.

708 Terminal Bidg., Toronto 1, Ontario, Canada

sonac is extremely rugged. Sensors are type 304 stainless steel. The electronic components in the sensors are hermetically sealed and will withstand pressures to 2000 psi and temperatures from -425° F. to +450° F. They are immune to shock, vibration or mechanical damage.

The control is a compact unit 5" x 5" x 5" and features transistor circuitry. Power consumption is one watt and the unit will operate in temperature ranges from 40° F. to 135° F.

Here's how sonac can be used for sensing and switching applications other than level control.



There are dozens of applications for sonac single and double sensor units. Let it go to work for you now, write:







From Redstone to Jupiter, Atlas to Thor—yes, even Freedom 7 and Liberty Bell 7—rocket and missile design has made the toughest demands on fastener engineers. To meet high shock and vibration factors, Meli-Ceil Inserts are specified as an unexcelled means of protecting all tapped threads. Yet they do it in standard boss configurations with material space and weight savings over any other insert or solid bushing. Proof? Every operational U.S. rocket, missile or space vehicle has taken aloft thread insurance in the form of Heli-Ceil Stainless Steel or "Inconel X" Wire Screw Thread Inserts.

ALSO RECOMMENDED FOR MAINTENANCE

Heli-Coil Inserts have U.S. military approval and are also recommended for maintenance work, to repair stripped, worn, or damaged tapped threads. Special military Heli-Coil thread repair kits have been developed through the cooperation of contractor, military and Heli-Coil personnel. Still other kits are available for all production salvage, repair and maintenance purposes.

Whatever your material—whether ferrous or nonferrous—even in hard or brittle materials which make the tapping of good threads difficult, installation of *Meli-Ceil* Stainless Steel Wire Screw Thread Inserts will provide permanent, perfect, reuseable threads. They will not strip, seize, gall or corrode. And *Heli-Ceil* "Inconel X" inserts provide these benefits, even at temperatures up to 1200°F.

Heli-Ceil Design Manuals should be among your working tools. Write for your copies today.

Reg. TM U.S. Pat. Ott.





HELI-COIL CORPORATION

In Canada: ARMSTRONG BEVERLEY ENGINEERING LTD. 6975 Jeanne Mance St., Montreal 15, Que. port loads in one or in two directions. One-way belting is nonreversible; two-way belting is a reversible conveyor system which transports the load in either direction. Belting negotiates convex or concave curves. May-Fran Mfg. Co., 1710 Clarkstone Rd., Cleveland 12, Ohio.

Circle 701 on Page 19

Pushbutton Control

is triple-function unit



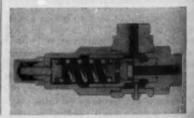
Single pushbutton unit combines three basic functions in one compact control: Pull to start; illuminated operating lens; push to stop. In addition to saving space, one-piece control requires less wiring time. It can be installed in any standard one-hole enclosure. Control incorporates a standard No. 51 6 to 8-v lamp coupled with a heavy-duty transformer. Models are available for either 115 or 230 v with a variety of operator lenses in six different colors. Mackworth G. Rees Inc., 1573 E. Forest Ave., Detroit 7, Mich.

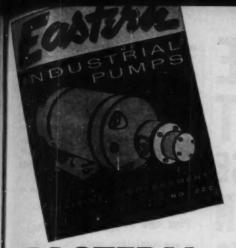
Circle 702 on Page 19

Relief Valves

for pressures to 500 psi

Adjustable, positive-seating, O-Seal relief valve is available for liquid or gas service to 5000 psi. Combining a resilient, flat, seated nylon disk with guided lift design, valve maintains a tight, leakproof seal until preset pressure is exceeded. Adjustable blowdown ring limits



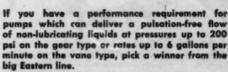


OP 2

EASTERN takes the gamble out of selecting

POSITIVE DISPLACEMENT

PUMPS



For small volumes against relatively high pres-sures, the Eastern GW series gear pumps are a natural. In each pump, oversized bearings of impregnated graphite support a drive gear of stainless steel and an idler of special bronze material. These self-priming units require no lubrication and cannot contaminate the liquid being pumped.

For volumes from 1.5 to 6 gpm and pressures to 60 psi, you can't beat Eastern VW series vane pumps. These highly efficient units are designed around a camshaped pumping chamber assuring pulsation-free liquid flow. Vanes are held in positive contact with the pumping chamber at all times — and their positioning is independent of hydraulic pressure or centrifugal force. Composition carbon graphite bearings and vanes require no lubrication beyond that of the liquid being pumped.

All Eastern positive displacement pumps are close-coupled with motor or can be furnished less electric motor with belt stand for belt or coupling drive.

Don't make your points the hard way — play safe and write for Eastern's new Bulletin 220 on positive displacement pumps.

Other Eastern products:

- hydraulic motors gear pumps
- e centrifugal pumps e aircraft pumps



EASTERN INDUSTRIES INCORPORATED

Hamden, Connecticut

Circle 386 on Page 19

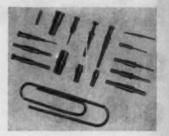
blowdown or pressure relief to within 10 per cent of the preset pressure. Available for pressure ranges of 300-1000, 1000-3000, or 3000-5000 psi with ½ or ¾-in. end connection, valves are for use at temperatures from -20 to +275 F. Combination Pump Valve Co., 848 Preston St., Philadelphia 4, Pa.

Circle 703 on Page 19

Pins and Sockets

are miniature units in over 100 configurations

Miniature and microminiature pins and sockets are designed for use on



printed-circuit boards and in similar limited-space applications. Over 100 different configurations are available from stock. Sockets are closed-entry, multiple-spring types. They accept wire diameters from 0.010 to 0.065 in. Pin sizes range from 0.017 to 0.060 in. diam. Omega Precision Inc., 757 N. Coney Ave, Azusa, Calif.

Circle 704 on Page 19

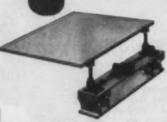
Air-Control Valve

for air or fluid-power applications

New 1-in., poppet-type, two-way, inline air control valve is available either normally open or normally closed and is for on-off control where air is used for processing or fluid-







An application with two Duff-Norton Worm Gear Jacks mounted on swivel subbase and each lifting screw end fastened to hinged member by means of clevis and pin. Jacks may be motor driven or manually operated.



Four Duff-Norton Worm Gear Jacks connected in rectangular arrangement by Duff-Norton Mitre Gear Boxes, shafting and flexible couplings and driven by gear motor to raise metal sheets to press level.



Six Duff-Norton Worm Gear Jacks as used on pipe-cut-off and threading machines to adjust height of machine spindle to level of conveyor table to compensate for various sizes of pipe.

Platen pressure obtained positively and uniformly by two Duff-Norton Worm Gear Jacks with rotating screws.

There are eight standard models of these jacks—capacities range from 2 to 100 tons, with standard raises up to 24 inches.

For engineering drawings of standard jacks, mitre gear boxes and more examples of how Duff-Norton Worm Gear Jacks are used for accurate movement of loads, write for Bulletin AD-66a-V.

DUFF-NORTON JACKS

DUFF-NORTON COMPANY

Four Gateway Center, Pittsburgh 22, Pennsylvania
The Canadian Duff-Norton Co., Ltd., Toronto 6, Ontario

DUFF-NORTON JACKS Ratchet • Screw Hydraulic • Worm Gear



Ratchet Lever • Air Hand Chain • Electric power applications. Valve is designed for service from vacuum to 200 psig, and is available in 3/4, I, and 11/4-in. NPT port sizes. Basic valve can be fitted with any pilot section available for the poppet-valve line. Hoffman Valves Inc., 2360 W. Dorothy Lane, Dayton 39, Ohio.

Circle 705 on Page 19

Spring Mountings

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for machinery and air-conditioning equipment

Type LNAA spring isolation mount cuts equipment installation time, maintains machinery efficiency, and stops vibration, shock, and structural noise transmission. Mounting, an isolator utilizing a single steel helical spring as the



cushioning medium, is available in load-carrying capacities from 50 to 540 lb. Range is provided by selection of four different springs which can be inserted into the isolator housing. Cast semisteel housing measures 33/4 x 31/4 x 51/8 in., and has an access port on each side which permits interior inspection, facilitates cleaning, and enables the spring to be changed in the field without dismantling the installation. Shock & Vibration Div., Korfund Co. Inc., Cantiague Road, Westbury, L. I., N. Y.

Lighted-Handle Switch

incorporates neon light behind rocker button

Lighted-handle, rocker-type switch is rated at 15 amp, 120 v ac. It is available in Despard (interchangeable) type with wide rocker to fit Despard plate openings, or in strap type with narrow rocker for use in



New METOHM line exceeds MIL-R-10509D

As a supplement to the unexcelled VITROHM resistors, Ward Leonard now offers to designers of commercial, military and industrial electronic equipment a line of molded metal film precision resistors, designed and tested to exceed the requirements of MIL-R-10509D, characteristics B, C and E. You can stake your reputation on Ward Leonard resistors.

Available in $\frac{1}{2}$, $\frac{1}{2}$ and $\frac{1}{2}$ watt sizes, W/L METOHM precision resistors feature the highest degree of built-in reliability and operating stability. Temperature coefficients, over the range -55° C to $+175^{\circ}$ C, may be as low as ± 25 parts per million. Standard tolerance $\pm 1\%$. Tolerances down to $\pm 0.1\%$ on special order.

метонм	MIL	RATED	OHMIC	MAX. VOLTAGE	
TYPE	EQUIVALENT	WATTS	MIN.	MAX.	RATING
WL 60	RN 60	3/6	30	500K	250 V.
WL 65	RN 65	34	50 -	1 meg.	300 V.
WL 70	RN 70	1/2	50	1.5 meg.	350 V.

Write for complete specifications and a list of distributors. Ward Leonard Electric Co., 58 South Street, Mount Vernon, New York.



RESULT-ENGINEERED CONTROLS

WARD LEONARD

BEGISTORS - BUEGGTATE - BELAVE - CONTROL S - DIMMERS



This new two-speed power take-off for heavy-duty tractors is typical of the precision assemblies produced at Warner Automotive Division for farm equipment manufacturers.

Simply by changing the output shaft, the farm operator can change his PTO speed from 540 RPM to 1000 RPM—a wonderful convenience in rush seasons. Variations of this principle are being applied to other types of farm implements.

Let Warner Automotive develop mechanical power transmission parts for your specific needs. Our engineering staff is at your service on any problem, without obligation.



BORG-WARNER CORPORATION AUBURN, INDIANA

For Hydraulic Power Transmission, See Wooster Division ME IN THE RESERVE OF THE PARTY OF THE PARTY

standard switch plates, in single-pole or three-way units. Neon lamp in back of the translucent rocker button gives off a glow when the switch is in "off" position. When on, rocker is not lighted. Pass & Seymour Inc., Solvay Station, Syracuse 9, N. Y.

Circle 707 on Page 19

Phenolic Glass Laminates

in thicknesses from 0.125 in.

Grade PG-381 high-temperature, phenolic-resin, glass-reinforced laminates are designed for applications requiring high-insulation and high-temperature properties. Laminates are available in thicknesses from 0.125 to 0.750-in. and greater. They meet the requirements of MIL-R-9299 (Type II Class 2), and are available in various sheet sizes from 9 x 10 to 20 x 36 in. Laminates have excellent machining characteristics and resist temperatures to 800 F. Mica Corp., 4031 Elenda St., Culver City, Calif.

Circle 708 on Page 19

Ceramic Capacitors

in values to 0.2 mfd

Ultra-Kap 20-v ceramic capacitors for use in semiconductor circuits are available in values to 0.2 mfd. They can be used as substitutes for paper capacitors and require less space than paper capacitors of equivalent capacity. Units have excellent stability from -55 to +85 C and are available in standard capacity values



Cuts Assembly Time by 75%

Here's fast Clamping Power for your Product . . .



Band is slipped over hose, duct or fitting — then through housing. A downward snap of the swivel screw locks clamp in position for screwdriver tightening. Application is easy, fast, positive.

Wide Adjustment Range for all Applications . . .



Twelve wide adjustment sizes cover diameters ½ to 12¼"... Select just one size to replace the many different sizes you are now using Snaplock can be used over and over again—rugged construction is fortified by 18-8 stainless steel in band and housing.

Typical uses for Snaplock are dust and filter bag connections, power tool attachments, sign hanging and a variety of hose, ducting and conduit applications.

FREE - DISCOVER FOR YOURSELFE

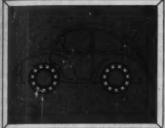
Send for a sample Snaplock clamp. And while you're at It, ask for the brochure describing a complete line of clamps for all industrial applications.



ISEAL COMPORATION 427 Liberty Avenue Sensitiyn 7, U. Y.







*MINA bearings

stimulate

industrial and commercial miniaturization programs

eliminate

both economic and technical barriers to using miniature ball bearings in a wide variety of products.



* MINA Bearing is the trade name for low cost ABEC-3 miniature ball bearings manufactured in U.S.A. b

MINA

of 0.05, 0.1, and 0.2 mfd. Centralab, Electronics Div., Globe-Union Inc., 900 E. Keefer Ave., Milwaukee 1, Wie

Circle 709 on Page 19

Gear Pump

in three series with output delivery from 7 to 97 gpm

Model X 2500-psi, continuous-duty, fluid-power gear pump is available in three series with output delivery from 7 to 97 gpm at 1800 rpm. All three series are recommended for continuous-duty operation at pressures to 2500 psi at 1800 rpm. Series 25 has a delivery range of 7 to 35 gpm; it is available with gear widths of $\frac{1}{2}$, $\frac{1}{2}$, and 2 in. Series 37



has a delivery range of 11 to 56 gpm, and is available in gear widths from 1.2 through $2\frac{1}{2}$ in. Series 65 has a delivery range of 45 to 97 gpm, and is available in gear widths from $1\frac{1}{2}$ through $3\frac{1}{4}$ in. Commercial Shearing & Stamping Co., Youngstown, Ohio.

Circle 710 on Page 19

Subminiature Circuit Breakers

are now available in two and three-pole models

Series SM circuit breakers are now furnished in two and three-pole models. Two-pole unit measures (without handle) 1.5 x 1.25 x 1.9 in., and three-pole model is 1.5 x 1.9 x 1.9 in. Both can be mounted with a single \(^4\)-in. diam panel output. Weight of the breakers is 31/4 and 41/2 oz, respectively. Housed in hermetically sealed metal cases, breakers resist shock, vibration, high humidity, salt-sea atmosphere, sand, and dust. Units can be furnished in any integral or fractional current rating from 0.050 to 15 amp.



CAPACITIES:
0.4 TO 1.6 GPM AT
2000 RPM AND 2000 PSI
DISPLACEMENT:
.05 TO .20 CU. IN.
MAXIMUM SPEED:
4000 RPM

Pressure loaded* for higher efficiency, longer life—Optional side, rear or combination porting—Special alloy tin-aluminum bearings as used in heavy-duty industrial engines, all interchangeable—Double lip shaft seal—Hardened and ground steel gears and shafts—High quality, high tensile aluminum bodies and covers.

Consult our Engineering Department for application of these pumps at higher pressures.

*Palent Nos. \$420622, 5863415, 3654525

WOOSTER BW

BORG-WARNER CORPORATION WOOSTER, OHIO

For Mechanical Power Transmission, See Warner Automotive Division

Circle 392 on Page 19



Standard voltage ratings are: 120 v ac, 60 cycles; 120 v ac, 400 cycles; 50 v dc. Heinemann Electric Co., 376 Magnetic Drive, Trenton 2, N. J.

Circle 711 on Page 19

Braided Packing

of carbon-free, white Teflon filament

Palmetto Style 1367 CF Teflon filament packing consists of braided, carbon-free, pure-white Teflon filament. Not prone to overheating, packing simplifies the break-in period after packing installation. It is inert to almost every known element, has heat resistance to 550 F, and has a low coefficient of friction. Greene, Tweed & Co., North Wales. Pa.

Circle 712 on Page 19

Control Switch, Outlet

in single, compact unit

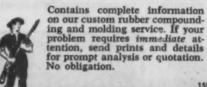
Compact grounded outlet and two switches are available in varied actuating-button colors. Unit is suitable for appliance, utility, and other applications requiring outlet and switches combined in a single compact package. Also available in black Bakelite, it is designed for snap-in panel mounting and simplified wiring. One switch can be used for fluorescent light control and one as a dummy or other circuit control. Switches are rated at 2 amp, 115 v ac, and outlet is rated





Colonial Rubber Company is geared to meet the rubber or silicone rubber parts requirements of product designers and purchasing people alike. We have a long background of industrial rubber experience, plus complete laboratory and production plant facilities to meet your "toughest" requirements economically and dependably.

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COLONIAL RUBBER CO.

RAVENNA, OHIO

AXminster 6-9611

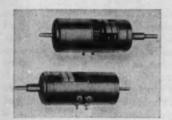
at 15 amp, 115 v ac. Switches have maintained push-on, push-off action. Molex Products Corp., 9515 Southview Ave., Brookfield, Ill.

Circle 713 on Page 19

Clutch-Brakes

are independent direct-action units

BuOrd Size 11 miniature magnetic clutch - brakes are double - coiled servo-instrument components which permit independent clutch or brake functions within a single unit. Two models are available: Frictioncoupled F-75 and crown toothcoupled F-85. The 3-oz, 1 1/16-in.



diam units have an energized break-away torque of 0.08 oz-in., de-energized breakaway torque of 0.03 oz-in., energized inertia of 0.060 in.-oz³, de-energized inertia of 0.025 in.-oz², and a power consumption of 3 w per coil. F-75 offers a clutch and brake torque of 16 oz-in. min; crown tooth-coupled unit offers a clutch torque of 60 oz-in. min and 16 oz-in. brake torque. Both units develop torque by magnetic attraction with a spring-loaded release. Fae Instrument Corp., 16 Norden Lane, Huntington Station, N. Y.

Circle 714 on Page 19

Printed-Circuit Connector

accommodates printed circuits measuring 0.054 to 0.071 in.

New printed-circuit connector has 130 contacts on 0.100-in. contact centers. Double-row connector has staggered terminations that facilitate soldering operations, and a solid barrier which divides the connector at the 32nd and 33rd contacts. Insulator material is diallyl phthalate and contact material is beryllium copper, gold over silver plate. Current rating is 2 amp and voltage breakdown at sea level is



For fast, secure, more economical fastening, the new Cherry Commercial Rivet is a blind fastener ideal for production manufacturing and repair. Installed by one man from one side of the work, the Cherry Commercial Rivet reduces cost of asscrably, repair and maintenance in both blind and open applications.

Minimum blind side clearance, adaptability to variations in material thickness, and positive hole fill even in oversize or out-ofround holes offer advantages not available in other production

fasteners.

Cherry Commercial Rivets are available in both hollow (nonstructural) and plugged (structural) types. The plugged rivets have strength values comparable to solid rivets, and stems fracture to eliminate all trimming operations and provide further production economy.

Grip lengths from ½" to 1" inclusive, and diameters of ½", ½", %" and ½" are provided in either universal or countersunk head.

Special rivets are manufactured to order.

For full technical information on the new Cherry Commercial Rivet, write Cherry Rivet Division, Townsend Company, Box 2157-E, Santa Ana, California.

Juminum Mild Steel Monel

Townsend Company

In Canada: Parmenter & Bulloch Manufacturing Company, Limited, Gananaque, Onlarlo

EXCLUSIVE WITH CARTER! ROD SCRAPER PLUS ROD WIPER AS STANDARD

J. I. C. Interchangeable A UARELINE Series features a Metal Rod Scraper plus a Rod Wiper in a quick change Cartridge—Double protection against chips, dirt, damage. Unitized cartridge rod bearing . . . easy removal and replacement . . . no cylinder disassembly necessary!



AIR and 2000-3000 psi HYDRAULIC

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- e True cushion-automatic concentric alignment
- ble a Positive piston locknut design a Delivery from stock!

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ROUNDLINE AIR-HYDRAULIC



- Space saving designs! Light weight!
- Full 1 to 1 Machanite cartridge rod bearing.
- Precision honed heavy wall tubing-6 to 1 safety factor.
- Spring landed "V" packing on rod and gland.
- Key type stainless steel locking ring. Allows 360° orientation of pipe ports.

ROTARY TORQUE ACTUATOR

- New design apportunities
- o To 370° rotation as standard
- e Safe, powerful torque
- e Air, oil, gas, water operation
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STANDARD ROTATIONS 0-280 0-196 0-370

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plete bound file. Air and aulic cylinders. Rotaries. clamp cylinders air valves, and the new spinasting. Complete details and prices SEND TODAY



NEW PARTS AND MATERIALS



2200 v ac. Printed-circuit boards measuring 0.054 to 0.071 in. are accommodated. Over-all dimensions of the connector are 7.60 x 0.50 x 0.50 in. Viking Industries Inc., 21343 Roscoe Blvd., Canoga Park Calif.

Circle 715 on Page 19

Solenoid Valve

for pressures to 1000 psi air, 850 psi water and light oil

No. 8223 two-way, high-pressure solenoid valve is especially suited for hydraulic applications. Of normally open construction, valve operates at pressures to 1000 psi air and 850 psi water and light oil. It is supplied in 1/2-in. NPT pipe size, with brass body and integral seat, and composition disc. available with general-purpose, watertight, or explosion proof solenoid enclosures, and can be mounted in



any position without affecting operation. Automatic Switch Co., Florham Park, N. J.

Circle 716 en Page 19

Epoxy-Sealed Switches

protect internal mechanism against moisture

Prewired and epoxy-sealed switches have the wiring entrance sealed with an epoxy potting compound to protect the internal mechanism against moisture. Loxswitch Model L and Model M switches are available with the conduit entrance of the switch sealed, as well as the normal gasketed openings. Switches are furnished prewired with 6 ft of No. 14 machine-tool wire. Conduit threads are unblocked for normal conduit attachment. Model L switches are also available for manifold mounting, with no conduit opening and back wiring entrance epoxy sealed. Two-circuit switches are provided with four leads, and three-circuit switches have six leads. All circuits are iso-



lated and color coded. R. B. Denison Mfg. Co., 386 Broadway, Bedford, Ohio.

Circle 717 on Page 19

Clutch-Brake Assemblies

are available in two sizes

New electromagnetic clutch and brake combinations utilize clutches, brakes, and continuous - slip clutches and brakes in an in-line construction. Units can be combined in almost any desired combination to produce a variety of operating characteristics. Each half of the set can be selected to conform to the driving or braking needs of the equipment, without compromising the specifications for the other half. Zero backlash, zero residual drag, and complete release are standard on all units. Torque output is 30 oz-in. at 2 w power input for size 100 and 110 oz-in. at 31/2 w for size 130. Torque for the size 100 is 0-10 oz-in. and 0-40 oz-In. for the size 130. Standard volt-





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How <u>critical</u> can you be in your selection of a fastener for a special application . . . especially when extreme accuracy, reliability and consistent performance are specifications. For over thirty years, Chandler has been producing special fasteners and standard cap screws and bolts that meet these demanding requirements.

If you have a special fastener problem . . . here's what you can expect from Chandler. Into the design of your special fastener goes the knowledge of expert Chandler engineers . . . careful attention to detail and exhaustive testing to meet critical standards . . . advanced production methods to assure on-time delivery . . . RESULT . . . a precise fastener, custom-tailored and mass-produced at the most favorable cost.

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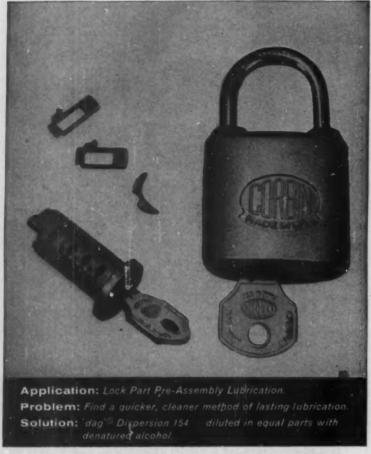
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1494 Chardon Road . Cleveland 17, Ohio

Products

LUBRICATION REPORT

(dry film coating)



RESULT: CLEANER, MORE UNIFORM, LONGER-LASTING LUBRICATION ON LOCK PARTS

Cam retainers and disc tumblers used in American Hardware Corporation's padlocks are 1/2 by 1/4 inch brass stampings. Because of their small size, this New Britain, Conn. manufacturer has found dipping to be the most efficient method of lubricating them. Acheson's 'dag' 154 proved to be ideal for this operation. Its alcohol carrier quickly evaporates, leaving a permanent film of graphite on the parts. This microscopically thin film is deposited uniformly, adheres tenaciously, and will not rub off during lock assembly. Since it does not attract dust and discourages oxidation and corrosion of the brass parts, 'dag' 154 provides a longer, smoother operating life for the locks.

For more information on the advantages of Acheson dry-film lubricants in product design, send for your copy of Bulletin No. 435. Write to Dept. MD-101.

ACHESON - First name in solid lubricants for fifty-three years.



PORT HURON, MICHIGAN A division of Acheson Industries. Inc.

Sales offices in principal cities.

Also Acheson Industries (Europe) Ltd. and affiliates, London, England

NEW PARTS AND MATERIALS

ages are 6, 12, 28, 48, and 100 v dc; any combination of these can be specified for the two halves of the combination. Dial Products Co., 19 Cottage St., Bayonne, N. J.

Circle 718 on Page 19

Liquid-Level Gages

are available in six new units



Six flush-mounted, press-fit, liquid-level gages are available in 38 styles and sizes. They range from simple, economical porthole windows to the Observa-Dome unit which makes the oil level easy to read from both side and front. All have windows of clear glass or clear, acrylic plastic. Glass-window styles are recommended for applications of 50 psi to 300 F; plastic-window styles take 10 psi to 100 F, or 2 psi to 160 F. Gits Bros. Mfg. Co., 1866 S. Kilbourn Ave., Chicago, Ill.

Circle 719 on Page 19

Selector Switches

are key-operated units

Type H (NEMA 1) and HO (oiltight) key-operated selector switches are available in two, three, or four positions and are supplied for either base or panel mountings. Group coding is provided for, since ferrules are offered in eight colors. Switches include melamine contact blocks which can be supplied with several contact arrangements. All contacts have wiping action. Wide selection

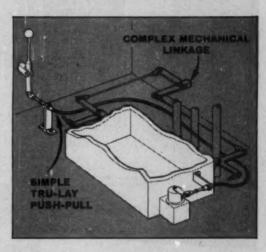


Dependable **Economical** Easy-to-Use

of



• If your products involve remote control-electrical, hydraulic, pneumatic or direct—TRU-LAY PUSH-PULL FLEX-IBLE CONTROLS can help solve your design problems. They provide positive remote control over long or short distances -up to 150 feet from the control point. Because they operate while flexing, they can snake around obstructions. They will not buckle. They're factory-lubricated for life, unaffected by temperature extremes. They are ruggedly constructed, easily installed and operated, sealed against dirt and moisture, and will handle jobs with as much as 1,000 lbs. input. PUSH-PULL CONTROLS are simple, have but one moving part, are noiseless, and give a lifetime of accuracy. Mechanical linkages, on the other hand, are complex. Unlike PUSH-PULL CONTROLS, they are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.



CABLE SIZES AVAILABLE

Control Dimension	Minimum Recommended Radius in Inches	Maximum Input Load in Pounds (Dependent on Travel)		
3/32"	2	30		
1/8"	3	85-125		
3/16"	5	115-175		
1/4"	6	300-600		
5/18"	8	700-1,000		

but where operation must be smooth and accurate. Meets all requirements for depend-

Operating Heads to Fit Your Design

for loads up to 125 lbs.

Heavy Duty . For rugged duty, ability and life.

Light Duty . Smooth, accurate, dependable performance at low cost. Your choice of several types of knobs.

Selective Friction • Amount of friction can be changed to meet individual requirements. Friction constant at any setting.

Position Lock . A slight turn of the T-type handle locks the control in any position. Two sizes for light and heavy-duty applications.

Micro Control . Push or pull the knob for instantaneous response, then rotate knob for vernier adjustment.



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Write for your PUSH-PULL Data File. It contains a complete set of engineering bulletins which describe in detail the operation of PUSH-PULL CONTROLS, their applications, features and advantages.

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Automotive and Aircraft Division . American Chain & Cable Company, Inc.

601-A Stephenson Bldg., Detroit 2 6800-A East Acco Street, Los Angeles 22 · 929-A Connecticut Ave., Bridgeport 2, Conn.





Wood's stationary control, variable speed drives, including SVS types, are available in capacities from fractional to over 300 hp using conventional v-belts. Wide range VPS types are available in capacities from 1 to 20 hp.

Write for BULLETIN 6102.



T. B. WOOD'S SONS COMPANY - CHAMBERSBURG, PENNSYLVANIA

ATLANTA · CAMBRIDGE · CHICAGO · CLEVELAND · DALLAS

SVS/2361

of cams provides a variety of contact operating arrangements. Clark Controller Co., 1146 E. 152nd St., Cleveland 10. Ohio.

Circle 720 on Page 19

Piston Pump

is available in 2 and 3-gpm sizes at 1800 rpm speed

Small-Twin Model 5300 direct motor-driven piston pump operates at pressures to 500 lb. The two-cylinder pump handles a variety of solutions and suspension - type chemicals. It is available in 2 and 3-gpm sizes at the maximum speed of 1800 rpm. Ports are tapped ½ in. NPT; stainless-steel shaft is ¾ in. diam with keyway. Two heavy-



duty, sealed ball bearings support the stainless-steel drive shaft. Hypro Engineering Inc., 700 39th Ave. N.E., Minneapolis 21, Minn.

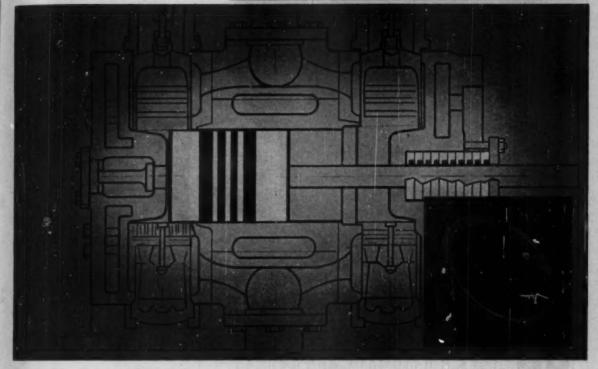
Circle 721 on Page 19

Motor Bases

automatically provide proper belt tension

Three new series of all-welded, tension-controlling motor bases have freely movable carriages. Known as Automatic, bases eliminate excessive wear on belts and bearings by automatically providing the proper belt tension, even under heavy starting loads. Readjustment, when necessary, is made while operating under load by turning a screw. Series 100 motor base is available in standard and vertical types for 19 NEMA frame sizes from 56 through 326-U. Series 200 is available in the same NEMA frame sizes as the 100 series. BB series, consisting of two standard





How piston rings of TEFLON° eliminated fire hazard and saved \$4,500 per year

TO USE TEFLON?

19

- Piston rings of Du Pont Teflon are your most economical choice whenever product contamination is a problem... whenever maintenance costs should be cut... whenever lubrication should be reduced or completely eliminated.
- Rings of Du Pont Teflon can permit bonedry operation . . . provide more uniform output because there is less gas blow-by . . . reduce danger of fretting, galling, and cylinder wear.
- Rings of Teflon are not brittle . . . resist chipping, cracking, breaking . . . installation, storage, and handling are easier.
- Kings of Terlon make possible substantial savings in operating, maintenance, and replacement costs.

Oil contamination in an instrument air system caused serious probblems in a large manufacturing plant. Oil plugging the lines not only led to heavy maintenance costs, but also created a dangerous fire hazard. Converting the eight instrument air compressors to piston rings of Teflon solved the problems and saved the plant money.

The greatly reduced lubrication required with rings of TeFLON (no oil at all was added to the cylinder) eliminated the oil contamination and system plugging. In addition to cutting the plant's maintenance costs substantially, the rings of TeFLON lasted longer than the previously used carbon rings, saving \$3,000 per year in ring cost, and virtually eliminated cylinder wear, saving another \$1,500 per year in cylinder refinishing.

If you are buying a new compressor, specify rings and packings of a Teflon TFE resin. To convert your present equipment, check with your compressor manufacturer or qualified ring supplier for engineering and design assistance. For further information, write: E. I. du Pont de Nemours & Co. (Inc.), Dept. MD-10-T, Room 2526, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, Box 660, Montreal, Quebec.



TEFLON

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

BETTER THINGS FOR BETTER LIVING ... THROUGH CHEMISTRY



keeps your equipment on the job -and out of the repair shop

You can't find a source of power that is better protected than the new V-460D valve-in-head Wisconsin. It's de-signed to keep your equipment working and your customers satisfied

Improved cooling assures dependable power at extreme temperatures. The center main roller bearing and tapered roller main end bearings supporting the forged-steel crankshaft make bearing failure almost unheard of.

Stellite-faced exhaust valves and positive rotators spare users the cost of up to four ordinary valve jobs. Controlled pressurized lubrication maintains full-time oiling to all working parts. A plastic pre-cleaner and an oil-bath air cleaner keep dirt out of the engine.

The V-460D has automatic protection against over-

The V-4c0D has automatic protection against overheating and negligence of routine engine care. Snap-off cylinder-head covers guard the cooling fins and spark plugs against damage, dirt, and condensation build-up. These and other features protect users of your equipment against costly power failure. Make sure by powering it with the best-protected engine made — the new 60-hp air-cooled V-460D Wisconsin. Send for Bulletin S-282. Write to Dept. O-11.



WISCONSIN MOTOR CORPORATION

MILWAUKEE 46, WISCONSIN

World's Largest Builders of Heavy-Duty Air-Cooled Engines

and vertical models, is available in BB 10 for NEMA sizes 364 through 505 and BB 400 for rerated NEMA frame sizes 364-U through 445-U. Manheim Mfg. & Belting Co., Manheim, Pa.

Circle 722 on Page 19

Air Cylinders

have up to 3-in. stroke lengths



Single-acting, spring-return, stainless-steel air cylinders are now available in 11/2-in. bore size, up to 3-in. stroke lengths. Units have mirror-finish, stainless-steel body, U-cup mounted in aluminum-alloy piston, and rolled-in front and rear head design. A 3/4-16 hex nut is provided for front nose mounting. Bimba Mfg. Co., 101 Main St., Monee, Ill.

Circle 723 on Page 19

Plastic Pipe Fittings

in sizes and shapes for 1/16 through 1-in. pipe

Precision pipe fittings are available in Zytel, Teflon, PVC, Profax, polyethylene, Plaskon, Penton, Kel-F, and Delrin. They are furnished in a complete range of shapes and sizes for 1/16 through 1-in. nominal pipe size. Cajon Co., 902 E. 140th St., Cleveland 10, Ohio.

Circle 724 on Page 19

Speed Changer

has operating speeds from 1.8 to 4460 rpm

Vari-Tex speed changer is available in five different sizes from 1 to 30 hp. Unit provides stepless speed changes within standard speed ranges of 2:1 through 10:1 at operating speeds from 1.8 to 4460 rpm. Mechanical, electrical, and pneumatic control options afford a wide degree of versatility. Changer



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is available in vertical, horizontal, or 45-deg assemblies with dripproof, totally enclosed, explosion-proof, Super-Seal, or Synduction motors. Allis Chalmers Mfg. Co., Milwaukee 1, Wis.

Circle 725 on Page 19

Stainless-Steel Ball Valve

has Teflon seats for high corrosion resistance

Precision ball valve in Type 316 stainless steel is designed for corrosive fluids and gases and for general use in corrosive services. Combination of stainless steel and Teflon seats provides high corrosion resistance and life expectancy. Temperature range is from -20 to +400 F with Teflon seats and from -20 to +220 F with Buna-N seats.



Valve is available in ½ to 2-in. sizes. Lunkenheimer Co., Cincinnati, Ohio.

Circle 726 on Page 19

Pushbutton Timers

offer wide choice of time cycles

Series 6200 pushbutton timers provide a wide choice of time cycles, plus versatility in load-circuit wiring. Contacts, load circuits, and other internal parts are easily accessible. Series offers universal three or four-stud mounting. Dial frame is available in two finishes with interchangeable dial faces to



Are Small Precision Metal Parts Disturbing Your Sleep?

The manufacture of small precision metal parts—in large volume—can sometimes take on the aspects of a bad dream. The problems are frequently numerous and complex. Their solution calls for specialized experience.

Torrington is the leading specialist in this field. We have the skill, engineering experience and manufacturing facilities to produce—at high speed and economical cost—a tremendous variety of small metal parts of exceptional precision and uniformity.

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progress through precision SPECIAL METAL PARTS

HE TORRINGTON COMPANY

Torrington, Connecticut



provide up to four possible variations. Dial lens is glass. Br'stol Motor Div., Vocaline Co. of America Inc., Old Saybrook, Conn.

Circle 727 on Page 19

Oil-Level Sight Gages

for use with fire-resistant fluids

Model 8575-NON oil-level sight gages are for use with synthetic, emulsion, or water-based, fire-resistant fluids. Units have simple two-hole installation. They can be mounted on either thin or thick-walled tanks. Large oil-level markings are clearly visible through a



tempered-glass window. Century Hydraulics Div., Century-Detroit, 6101 Concord Ave., Detroit 11, Mich.

Circle 728 on Page 19

Germanium Transistors

are 0.130 x 0.130-in, size

Double-ended, subminiature germanium transistors are available for computer and switching, and general-purpose radio and audio-frequency applications. Actual size of the '20 units is 0.130 by 0.130 in, 21 times smaller than TO-5 equivalents. Temperature range is -65 to +85 C. Mounting possibilities include single and multiple-board



A small pneumatic power positioner that drives valves, dampers or other control devices with an accuracy rating of ±1% has been developed by Hagan Chemicals & Controls, Inc., of Pittsburgh. To insure longer service life, reduced replacement and maintenance costs and maximum reliability, Hagan specified TEFLON by SPARTA for the 3 parts shown.

This is but one example of the unlimited possibilities of imaginative designing tearned with the know-how, facilities and research of Sparta Manufacturing Company. THINK of TEFLON by SPARTA as the possible answer to your cost, design and performance problems . . . then CALL on the TEFLON experts at SPARTA to analyze your requirements and make recommendations based on these studies. A full-time staff engaged in research, planning and engineering has constantly kept pace with the clamor for new and unique applications.

Standard TEFLON shapes, such as tubing, rod, sheet, tape, molded billets and "O" rings are always available.

Call 4-2389 or write for detailed brochure or a visit from a sales engineer.

SPARTA

manufacturing company, dover, ohio

*Du Post trademark for its TFE-fluorocarbon rusin

configurations, feed-through construction, welded assemblies, and special assembly modifications. Semiconductor Div., Raytheon Corp., 150 California St., Newton, Mass.

Circle 729 on Page 19

Six-Speed Drive

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has remote-control, pushbutton panel

Selectro-Shift six-speed drive is available in 20, 25, 30, and 40-hp



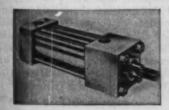
units. Hydraulic clutches activated by electric solenoids shift the drive to any of six speeds while running under full load. Shifting is controlled by an electric pushbutton station installed at any required distance from the drive. Unit is operated in either reverse or forward position in all six speeds. Lima Electric Motor Co. Inc., Lima, Ohio.

Circle 730 on Page 19

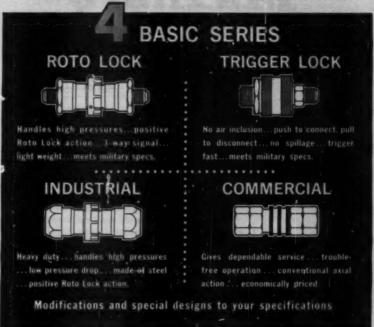
Hydraulic Cylinder

in 1/2 to 14-in. bore sizes

Series L square-head, general-purpose hydraulic cylinder, rated to 2000 psi, incorporates vee-type rod packing and a cylinder barrel of Microhoned steel tubing. Bore sizes are 1½ to 14 in. Construction features include a chrome-plated, hightensile-steel piston rod, long, cartidge-type rod bearing, and rolled-steel heads. Cylinder is inter-



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The Roto Lock and Trigger Lock Couplings are unexcelled for quick-connect applications over a wide range of high-integrity functions, from air to exotic fluids. In addition there is a series of new GSE Couplings for advanced pneumatic systems.

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With these performance-proved units, you can save time and money in designing and building clutches and brakes exactly tailored to the requirements of your application. At the same time, you can be sure that they will equal the performance and smooth operation of proved MAXITORQ clutches and brakes. DISC-PACS are simply the "heart" of a clutch or brake...the discs, separator springs, and locking plate... supplied as a complete self-contained unit for the convenience of design engineers and equipment builders.

Produced in a full range of sizes and capacities from ¼ h.p. to 15 h.p. Bulletins available on other MAXITORQ products: Floating Disc clutches and brakes, Electric clutches, Overload Release clutches, low-cost Single Disc clutches, and clutch or brake friction discs. Write Dept. MD.



THE CARLYLE JOHNSON MACHINE CO.

MANCHESTER, CONNECTICUT

3CJ66

Circle 405 on Page 19

NEW PARTS AND MATERIALS

changeable with most similar cylinders. Ortman-Miller Machine Co., 19 143rd St., Hammond, Ind.

Wirewound Potentiometer

in 10 to 50,000-ohm range



Series 320 subminiature wirewound potentiometer measures ½ x ½ x 5/32 in. It is available in 10 to 50,000 ohm range. Atohm Electronics, 7648 San Fernando Rd., Sun Valley, Calif.

Circle 732 on Page 19

Size-Eight Synchros

incorporate transparent end caps

Size 8 Rear-View synchros incoporate transparent end caps. Units, which contain electrical zero marks on the rear collector ring and rear of the brush block, permit observation and marking of electrical zero points. Brush area can be inspected after installation. Synchros meet all applicable MIL-spec requirements. Western Div., IMC Magnetics Corp., 6058 Walker Ave., Maywood, Calif.

Circle 733 on Page 19

Fluorescent Lampholders

for T-5 fluorescent lamps

Bi-pin lampholder for T-5 fluorescent lamps is available for 4, 6, 8, and 13-watt lamps, and measures 23/32 in. high by ¾ in. deep by 19/32 in. wide. Lampholder is furnished with 6-in. No. 18 AWG 105-C AWM plastic wire leads. Brackets are tapped for No. 6-32 mounting screws. Lampholders are rated 75 w, 250 v. Circle F Mfg. Co., 720 Monmouth St., Trenton, N. J.

Circle 734 on Page 19

MOTORS



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CON.

Operates 25,000 hours without re-oiling on light duty applications, uses specially designed sleeve bearing lubrication system. Over 550 motor styles rated 1/6 to 1 hp in variety of combinations of mechanical features are stocked by Westinghouse at all times to meet your instant needs. Write for Bulletins 2820 and 2850 to Westinghouse Electric Corp., Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

Westinghouse

Circle 406 on Page 19

NEW



Guardistor motors

Eliminate production shut-downs from motor burnouts! Static thermistors in windings sense critical temperatures—take motor off line, flash warning signal. No nuisance tripping—no parts to wear out or fail. Available on all new Westinghouse motors; all types of rewound motors. Write for Bulletin B-7876-R. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

Westinghouse

Circle 407 on Page 19

ENGINEERING DEPARTMENT

EQUIPMENT

Drafting Instrument

for fast application of self-sticking tapes

Quik Line tape pen permits the application of straight, curved, or irregular lines from 1/32 to 3/16 in. wide on any surface that accepts ink drawing, and on most surfaces that will not accept ink. Lines are uniform in width and density, and are accurate for placement to 0.010 in. Pen is balanced for fatigue-free use, requires no filling until the entire roll of tape is used. Corrections and changes are made



by lifting up the misplaced tape and replacing it. Wheel assembly at the lower extremity of the pen simultaneously feeds, applies, and burnishes the tape. W. H. Brady Co., Dept. 169, 789 Glendale Ave., Milwaukee 9, Wis.

Circle 735 on Page 19

Force Washers

are temperature-compensated for temperatures of 50 to 250 F

Temperature-compensated for ce washers, actually miniature load cells, approximate the shape of regular bolt washers. They are temperature compensated for temperatures of 50 to 250 F, and come in standard bolt sizes from 3/16 to 1 in. diam. Loads for these diameters range from 5000 to 35,-

NEW



STATIC SLIPSYN synchronous motor control

No moving parts, precise synchronizing control up to 99% of synchronous speed. Static networks eliminate corrosion and wear failures. Positive adjustable pull out protection avoids false tripping. Static damper winding, field loss and incomplete starting sequencing protection available. For new or old motor control installations. For details, write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

Westinghouse



Circle 408 on Page 19

NEW



Adjustiflow drive

Dual cooling system reduces belt wear... key to longer belt life. Liberal overload capacity—full rated h.p. at the output shaft. For more information write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure... if it's Westinghouse.

Westinghouse



Circle 409 on Page 19



In coils. Thicknesses from .020 to .070 in., widths of 2, 4, 6, 8 in. Ideal for punched parts under static or dynamic loads (gaskets, washers, closure liners, etc.).

See your nearest Hyde distributor or write for complete information.

A. L. HYDE CO.

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DISTRIBUTORS FROM COAST TO COAST

Circle 410 on Page 19



ZYTEL* 101 ROD - SLAB HEAVY-WALL TUBE

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ASSURED SELF-LUBRICATING SECURITY
WITH LUBBRITE

Self-Lubricating BEARINGS













Reporters Handling Equipment 6 Conveyor Systems









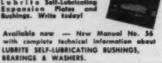
Lubrite self-lubricating bearings effer great versatility in hundreds of fields where dependability and superior performance are of prime importance.

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Sond for this free 20noge Lubrite Manual No. — it contains complete information, technical date and specifications about Lubrito Self-Lubricating Expansion Plates and Bushings. Witte Suday!



LUBRITE DIVISION MERRIMAN BROS., INC.

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000 lb, depending on bolt diameter selected. Temperature compensation is better than 0.5 mu in. per deg F over the 50 to 250 F range. Accuracies of better than ±1 per cent of full-scale sensitivity are held for linearity, repeatability, and hysteresis. Avionics & Industrial Products Div., Lockheed Electronics Co., 6201 E. Randolph St., Los Angeles 22, Calif.

Circle 736 on Page 19

Drafting Table

can be adjusted to any height or angle

Space-saving drafting table has new streamlined design and perfect counter-balancing, enabling the draftsman to adjust the table to any height or angle. It is available in silver grey color that



harmonizes with any decorative scheme. Unitech Corp., 50 Colfax Ave., Clifton, N. J.

Circle 737 on Page 19

X-Y Recorder

is designed for rack mounting

Model HR-95 X-Y recorder includes vacuum paper holddown, continuous ten-turn precision attenuators, and an electric pen lifter as standard. Attenuators can be

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Static design, less floor space, easy installation, flexible. System converts a-c to d-c to operate an adjustable speed d-c motor. Includes a power unit, main d-c drive motor and operator's control station. Available from 1 to 200 hp or larger. Write for Bulletin 560! to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

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Circle 412 on Page 19

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More torque for your money. Higher output torque for given input h.p. Meets all AGMA standards. Available in 1-20 h.p. range, ratios 5:1-70:1. Can be floor, ceiling, wall or vertically mounted. For B-8285 write to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

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Circle 413 on Page 19

ENGINEERING DEPT. EQUIPMENT

disconnected quickly for near infinite input impedance. Unit utilizes standard 8½ x 11 in. graph paper or new paper divided into 100 x 150 minor divisions. Options include carrying case for use in upright or horizontal position and zener-diode reference supplies. Snap-in pen construction is designed for standard recorder ink cartridges and permits various color traces on one graph. Recorder is available with either 1 or 10 mv per in. amplifiers. It is also available with 10 or 100 mv full scale



amplifiers for the 7-in. axis and 15 or 150 mv full scale amplifiers for the Y axis. Houston Instrument Corp., P. O. Box 22234, Houston 27, Tex.

Circle 738 on Page 19

Breadboarding Kit

provides for rapid assembly of prototypes

The 3-D construction set provides a convenient basis for assembling experimental models of electronic equipment, and enables the designer to complete prototypes without using any power tools except a soldering iron. Kit consists of prepunched laminated-phenolic panels; terminal strips; volume-control strips; silver-plated, snap-in turret terminals; punched chassis-frames; end-plates; rack-mounting plates; and assorted hardware. Panels have



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Circle 414 on Page 19

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Famous TBS features, plus new economy. Lowest priced high quality switchboard instrument available today. Taut Band Suspension K-221 instruments offer permanent accuracy and are unaffected by shock or vibration (even shocks caused by shipping installed in equipment). Meets or exceeds ASA Standard C-39.1. For TBS sample and Bulletin 43.220, write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.

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Circle 415 on Page 19

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T SERIES Thin-section, high precision radial ball bearings. Type TCR with maximum ball complement and retainer — Type TCF with full race ball complement — Type TWF with unique integral shield.



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Small, thin-section radial ball bearings with maximum ball complements and one-piece retainers — high concentration of load capacity in minimal space results in tremendous space savings.

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holes for both miniature and octal tube-sockets, for potentiometer-shaft bushings, and for snap-in terminals. Chassis frames are 16½ in. long; with mounting plates, they fit standard 19-in. racks. Precision Metal Products Co., 41 Elm St., Stoneham, Mass.

Circle 739 on Page 19

Solution-Metering Pump

for use in measuring small quantities of fluid

Solution-metering pump delivers minute quantities of a variety of liquids. It is available in four ranges: 0-2, 0-5, 0-10, or 0-20 milliliters per min. Simple turn of a precalibrated knob sets liquid flow with an accuracy of ±2 per cent of full range. Re-



peatability is better than ±0.5 per cent of rated capacity. Internal components are constructed of inert materials to permit the handling of most corrosive fluids, and to prevent solution contamination. Unit is easily disassembled. Scientific & Process Instruments Div., Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, Calif.

Circle 740 on Page 19

Pressure Cell

permits precise static measurement

HF Series miniature pressure cell utilizes semiconductor strain gages. Cell permits precise static measurement in addition to fast rise time and flat frequency response over a wide range of dynamic measurements. It has low sensitivity to thermal gradient, shock, and acceleration, which makes it well suited to tunnel, shock tube, and air-foil testing. Capacities from 5 to 500 psig

provide outputs in excess of 100 mv with natural frequency in excess of 50 kc. Cells withstand 1000 g in all axes with a maximum error of

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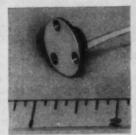
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0.005 per cent per g. Kulite-Bytrex Corp., 50 Hunt St., Newton 58,

Circle 741 on Page 19

Strain Indicator

operates from batteries or external ac supply

Model PS7-LT portable, transistorized strain indicator operates from self-contained batteries or external Measurement bridge ac supply. can be balanced, using integral controls, after which strain is read directly from the instrument. Multipoint and long-term strain measurements are also possible. Separate output connections are used for display on an oscilloscope, oscillograph, or pen-type recorder. Linear calibrated null meter makes possible the direct measurement of low values of strain. Metrix Inc., P. O. Box 683, Walnut Creek, Calif.

Circle 742 on Page 19

Small Thermocouple

in Chromel-Alumel or Iron-Constantan types

Monitemp Mark III thermocouple has high accuracy. Small size holds heat dissipation to a minimum, and a stainless-steel retaining nut that is free from the thermocouple permits installation and disassembly without twisting stainless-steel braided cable and recording instruments. Cable is available in any length in Chromel-Alumel or Iron-Constantan types. Advanced Products Co., 59 Broadway, North Haven, Conn.

Circle 743 on Page 19



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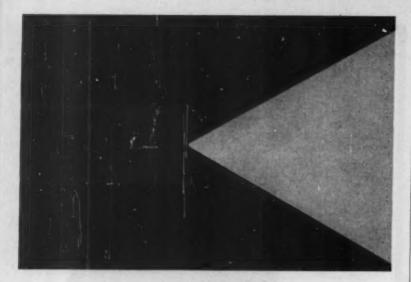
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THE ENGINEER'S

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Recent Books

Design of Machine Elements, 3rd Edition. By M. F. Spotts; 583 pages, 6 by 9 in., clothbound; published by Prentice-Hall, Inc., Englewood Cliffs, N. J.; available from Machine Design, \$13.35 post-paid.

This book offers analytical techniques used for the design of various machine elements and includes material selection, heat treatment, strength, fatigue resistance, lubrication, wear, and tolerances. Each chapter has extensive bibliographical material along with numerous worked-out examples. The author first covers theories of mechanics and strength of materials proceeding on to stress concentration and repeated loading. Also included are detailed discussions on basic machine members such as shafts, springs, screws, bearings, gears, cams, and press fits.

Conversion Factors and Tables. By O. T. Zimmerman and Irvin Lavine; 680 pages, 4½ by 6½ in.; published by Industrial Research Service, Masonic Bldg, Dover, New Hampshire. \$7.50 per copy.

This third edition provides a source of fundamental physical relationships and thousands of constants for the conversion of units. For example, conversion tables include hydrometer conversions, viscosity conversions, hardness conversions, Mohs' scale of hardness, wire and sheet metal gages, standard sieve sizes, and hardness conversion factors for hardened steel and steel alloys.

Applied Mathematics for Radio and Communication Engineers. By Carl E. Smith; 336 pages, 5½ by 8 in., paperbound; published by Dover Publications Inc., 180 Varick St., New York 14, N. Y. \$1.75 per copy.

This book begins with the fundamentals of arithmetic, logarithms, algebra, geometry, and trigonometry. The author gives special



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Technical-ities
by Fred E. Graves

Avoiding Bolt Failure Under Dynamic Loads

Dynamic loading in a tightened belt may vary from no stress at all to that exceeding the belt preload.

A classic example of dynamic loading is a connecting rod in a reciprocating engine. But you encounter such cyclic stress wherever you have fastened members that move or vibrate.

It has been shown that when the fluctuating stress approaches or exceeds actual bolt tension early fatigue failure can be expected.

DEMONSTRATION

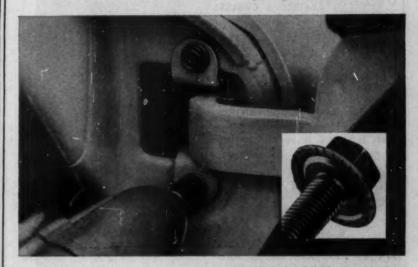
In tests, bolts tightened to a 1420 pound tension and stressed cyclically to 9215 pounds, failed after only 5960 cycles. Identical bolts tightened to 8420 pounds, and cyclically stressed to the same 9215 pounds, went 4.65 million cycles before failing.

Had the bolts been tightened to beyond the 9215 pounds, it would have been impractical to try to cycle them to failure.

So, if you want to avoid fatigue failure, be sure bolt tension exceeds the maximum dynamic load, known or estimated. This way, the bolt's life under dynamic loading will approach its life under static loading.

Take advantage of the high residual tension available to you in today's high strength bolts and screws, and thereby avoid fastener failures.

Why Tensilock*screws make ideal fasteners for "double-duty" jobs



TENSILOCK screws are engineered to prevent both slippage and loosening.

Heat-treated, they are so strong—even stronger in ultimate tensile strength than high-strength hex screws—that they can keep fastened members from slipping by high clamping force. As an added benefit, this permits more liberal tolerance in metalworking operations. Holes in fastened members can be oversize, slotted, eccentric, misaligned.

LOCKED-IN PLACE

Once they're tightened down, Tensilock screws can't shake or vibrate loose under reasonable service conditions. Sharp, angular, carburized teeth beneath their heads bite in to resist counter-clockwise loosening tendencies. To back off, 25% more off-torque is required than on-torque.

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Tensilock screws combine an integral washer with their self-locking feature for a unique one-piece fastener that speeds assembly.

Moreover, with their higher clamping force, it's possible that three Tensilock screws will do the job as well, or better, than four Grade 2 fasteners.

To take advantage of them, we suggest you call in an RB&W technical advisor. Or, write for Bulletin TL-2. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N.Y.

Plants at: Part Chesier, N. Y.; Ceroopoiis, Pa.; Rock Falis, Ill.; Los Angeles, Cailf, Additional sales offices at: Ardmore (Phila:), Pa.; Pittsburgh; Detrait; Chicago, Dailos; San Francisco.



emphasis to vector addition and complex quantities including illustrations from electrical and radic theory. Following chapters cover the requirements of simultaneous equations in mesh circuits and quadratic equations in complex circuits having multiple resonance frequencies. Additional chapters cover hyperbolic trigonometry, uses of differential calculus in treating both algebraic and transcendental functions, integral calculus, and series and wave forms.

Supersonic Aerodynamics, A Theoretical Introduction. By E. R. C. Miles; 255 pages, 51/4 by 8 in., paperbound; published by Dover Publications Inc., 180 Varick St., New York 14, N. Y.; \$1.45 per copy.

One of the principal purposes of this book is to assemble the basic tools for further theoretical investigation and for the understanding of current professional literature. The first chapter discusses fundamental theory including perfect gases, entropy, steady flow, velocity of sound, the mass flow function and equations of fluid motion. Succeeding chapters cover divergence and circulation, the potential equation, characteristics in the plane, linear theory of plane flow, the linear potential equation in three dimensions, shock waves, and comparisons of adiabatic and shock flow in two dimensions.

Flow Meter Handbook. Edited by C. F. Cusick; 170 pages, 8 by 10½ in., cloth-bound; published by Minneapolis-Honeywell Regulator Co., Brown Instrument Div., Philadelphia 44, Pa.; \$7.50 per copy.

In this third edition basic data have been rearranged and the scope expanded to include information on primary devices other than orifice plates. This rearrangement consists primarily of including in each of the first three chapters all the data necessary to calculate or check an orifice plate for a specific fluid application. In each of these chapters three solutions are outlined for a flow problem: An approximate check, a nominal orifice-bore calculation, and a precise orifice-bore calculation. Sample chapter titles are general data on flow calculations for primary devices other than concentric orifice plates, general data on open-channel flow, the



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derivation of a universal formula for fluid measurement, and the derivation of working equations for fluid measurement.

Silicon Zener Diode and Rectifier Handbook. Compiled by the Applications Engineering Dept. of Motorola's Semiconductor Products Div.; 182 pages, 6 by 81/2 in., paperbound; published by Motorola Inc. 5005 E. McDowell, Phoenix, Arizona; \$2.00 per copu.

This handbook is concerned with two special kinds of semiconductor devices, silicon-zener diodes and silicon rectifiers. The zener is a voltage-limiting diode that has some properties in common with the older voltage-regulating tubes, but allows much wider application. Some of the more important applications are discussed to illustrate various uses. Chapter titles include comparisons of gaseous tubes and zener diodes, regulated power supplies, surge protection, ac and dc amplifiers, temperature compensation and impedance cancellation, and the diffused-junction silicon rectifier.

How to Design and Specify Printed Circuits. Edited by The Institute of Printed Circuits; 92 pages, 6 by 9 in., paperbound, stapled; \$1.00 per copy.

This report contains the "knowhow" of pioneer firms in the design and manufacture of printed wiring devices. It gives a general technical explanation of the sequence in adapting electrical and electronic wiring circuits to a single or coplanar printed wiring connecting structure. Topics covered include: Applications of prefabricated wiring, production methods, processing limitations, selection of materials, I.P.C. tolerances and reliability.

Gyroscopes: Theory and Design. Edited by Paul H. Sauet; 410 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., New York, N. Y.; available from Machine Design, \$12.75 postpaid.

This book deals with design practices for quality gyros of high performance and operational reliability. Applications presented include gyro compasses, stable verticals and recent developments in inertial guidance. Topics covered include: Fundamentals of vector and transformation calculus; fundamental mechanical analysis of a theoretical



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ideal gyro; stable gyroverticals; inertial guidance fundamentals as applied to both short-duration ballistic vehicles and long-duration cruise ships; design and analysis; electrical characteristics of gyros; and test procedures for all types of gyros. "Schuler tuning" and its relation to the earth's curvature are also discussed in detail.

ASTM Standards on Petroleum Products and Lubricants, Volume I and II. Edited bu ASTM Committee D-2: 37th Edition. 1130 and 696 pages, respectively, 6 by 9 in., clothbound; published by The American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; \$9.50 and \$7.50, respectively (ASTM members: \$7.60 and \$6.00).

Volume I contains those methods of test, specifications, definitions, charts and tables which find most frequent use in the testing of petroleum products and lubricants, including several general specifications for laboratory testing apparatus. The volume also includes a number of proposed methods of test in draft form for comment.

Volume II presents a number of related standards of interest to the petroleum industry prepared by other ASTM technical committees It covers such materials as gaseom fuels, industrial aromatic hydrocarbons, bituminous materials, electric insulating oils, waterproofing materials, wax polishes, etc.

Government Publications

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

TN D-735. The Stiffness Properties of Stressed Fabrics as Obtained from Model Tests, Ry George W. Bender and Jerry W. Deaton, Langley Research Center; 17 pages, 7% by 10% in., paperbound, stapled; \$0.59 per copy.

The stiffness properties of a nylon-neoprese fabric material subjected to uniaxial, biaxial or shear stresses as obtained from tests of simple models are presented. The stiffness properties are applicable to problems involving applied loads after the fabric is in an initial state of biaxial tension.

PB 171389. Research on High Temp. Complex Component Development. Preparally Research and Development Communications pages, 8 by 10½ in. paperbound, stapled per copy.

The report covers the development of a new microminiature concept, the Rc (resistance coupled) circuit plate. Associated with circuit plate is an interconnection scheme that employs printed-circuit techniques, This allow circuits to be assembled into modules and "supermodules" for complex equipment without soldsred wire connections.



Design efficiency is the keynote of the new Webcor Tape Recorder line for 1961. An example is the square section neoprene belt that drives the tape footage counter. Developed by Webcor and WILBOW engineers as a cooperative project, this new belt provides improved characteristics of strength, recovery and uniformity of tension . . . at lower cost!

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Simplified Vibration Analysis by Mobility and Impedance Methods, by R. P. Thorn & A. H. Church, 1959-1960 (80 pp.) \$2
Inside the Engineer, by Eugene Raudsepp, 1958-1960 (52 pp.) \$1
Mobility of Cross-Country Vehicles, by M. G. Bekker, 1959-1960 (32 pp.) \$1
Engineering Approach to Hydraulic Lines, by Jaroslav J. Taborek, 1959 (36 pp.) \$1
Planning New Products, by Philip Marvin, 1953-1958 (102 pp.) \$3
Friction-Clutch Transmissions, by Z. J. Zania, 1958 (30 pp.) \$1
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Special Report on Electric Motors, Staff Report, 1958 (42 pp.) \$1
Electronic and Electric Power Supplies (Symposium), 1958 (40 pp.) \$1
Human-Factors Engineering, by J. D. Vandenburg and C. T. Goldsmith, 1958 (32 pp.) \$1

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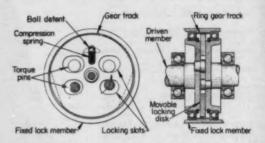
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Override Protection Device

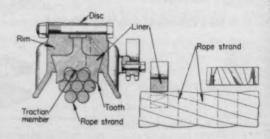
A positive gear lock prevents a driven shaft from overriding the driving shaft, but permits shaft rotation in both directions. The upper two torque pins, as shown, are attached to the driven member; the bottom two, to the driving member. A locking disc with an enlarged central hole can move radially. As long as the driving torque pin produces an "upward" force on the locking



disc (and consequently, on the driven torque pin), teeth on the locking disc are held away from the fixed lock member. But if the driven torque pin overrides, producing a "downward" force, teeth on the locking disc are engaged with the fixed lock member. The spring and ball detent merely provide enough force to overcome friction and balance the lock ring's weight when it is upside-down from the position shown. Patent 2,995,226 assigned to Electrical Engineering and Mfg. Corp., Los Angeles, Calif., by John A. Gilder.

Cable-Riding Traction Drive

Grooved pulley liners which mesh with the contours of a wire rope provide the traction for a self-propelling aerial transporter drive. Grooves in the traction mem-



bers, which are arranged around the perimeter of a rotating pulley, are tapered to grip the rope strands. To keep the rope from turning, the outside teeth on the traction member each rest on the upper side of a strand, cancelling out torsional forces. The pulley can ride on rigid rails, using outside rims as bearing surfaces. The



This mobile rack for data processing tape is a typical example of Titchener custom design and manufacturing service.

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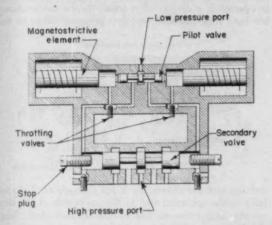


3 Titchener Place, Binghamton, New York

drive system eliminates separate hauling ropes and separate traction ropes. Patent 2,987,009 assigned to Colorado Fuel and Iron Corp., Colorado, by Leroy Nixon.

Electrically-Pulsed Valve

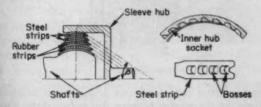
A high-speed fluid-control valve, responsive to short electrical pulses, has a rapid response time. Paired electrical pulses, one negative and one positive, are fed to magnetostrictive elements (or piezoelectric crystals, or coil-operated diaphragms) to produce a momentary pressure unbalance. This pressure pulse moves a light-weight pilot valve, but is confined by throttling valves



from the rest of the system. Fluid fed continuously into the low-pressure port further unbalances the pilot spool, since flow, and pressure, are increased on one side of the system. This low-pressure fluid moves a heavier secondary valve, but much more slowly, to permit high-pressure fluid to be applied to an operating device. As the secondary spool moves, it acts as a piston, providing fluid pressure which forces the pilot valve back to a neutral position. The system then rebalances. Patent 2,993,477 assigned to International Business Machines Corp., New York, N. Y., by Hugo A. Panissidi.

High-Angularity Flexible Coupling

Combining the features of a flexible coupling and universal joint, a strip-type coupling permits high angular misalignment. Four to eight thin metal strips are wound



spirally between the socket and the hub, with spaces filled by thin rubber strips bonded on one side to the metal strips. A solid lubricant can be used on the other side. Heat generated by internal hysteresis in the rubber is dissipated through the steel strips. Dis-

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line and head-to-element lead.

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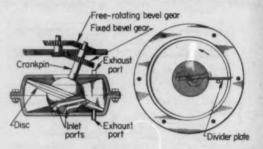




sipation is further aided by extending the metal strips to form fins. Metal strips are attached to the hub by forming bosses or lugs in the strips which mate with sockets in the hub. Patent 2,995,907 assigned to Societe Glaenzer Spicer Societe Anonyme, Poissy, France, by Michel Orain.

Nutating-Disc Motor

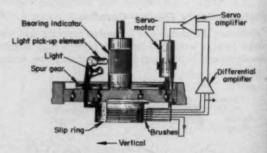
Air or expansible fluid is fed through the spherical seat of a nutating-disc motor to swing a crankpin in a circular arc. But rotation of the crankpin about its own axis is prevented by a differential-gear arrangement. In operation, a divider plate separates the motor chamber into high-pressure and low-pressure sides. In the



starting position shown, air is fed through an S-shaped inlet in the spherical seat to the lower side of the disc, on the high-pressure side of the divider plate. After the disc nutates 180 deg, air is then automatically ported to the upper side of the plate (still on the high-pressure side) to complete the 360-deg nutation. Patent 2,992,-635 assigned to Thompson Ramo Wooldridge Inc., Cleveland, Ohio, by Algirdas L. Nasvytis.

Low-Friction Bearing

To minimize friction in a bearing-supported shaft, an intermediate bearing ring is driven by a servo system in synchronism with the shaft, providing essentially zero relative rotation. A bearing indicator on the shaft is graduated or shaded so that light reflected into two



photosensitive cells (only one is shown) is balanced. Slight relative motion between the shaft and the intermediate bearing ring unbalances the system, causing the servomotor to drive the intermediate bearing ring and restore the zero relative position. To reduce static friction losses, the intermediate bearing ring can be dithered by feeding a low-frequency ac signal to the

amplifier. Patent 2,983,556 assigned to Vitro Corp. of America, New York, N. Y., by Edward M. Coan.

Gear-Transmission Shifting Brake

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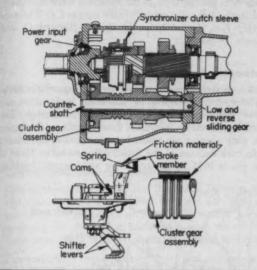
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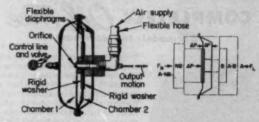
Mutiple-speed gear transmission incorporates a friction brake to reduce cluster-gear spin time following disengagement of the main clutch. Used on manually controlled transmissions which have counter-shaft arrangements, the brake consists of a cam-actuated curved friction segment which engages a grooved section of



the cluster gear shaft. The brake operating mechanism is linked to the synchronizer clutch sleeve so that the brake is engaged when the transmission is shifted into neutral position. The brake is self-energizing due to a turning moment set up by the coefficient of friction between the friction material and the grooved shaft section. This moment tends to rotate the brake into engagement, supplementing the normal spring forces. Patent 2,993,574 assigned to Ford Motor Co., Dearborn, Mich., by Robert H. Gardner.

Air-Powered Diaphragm Actuator

Controlled by a simple on-off valve at the end of a control hose or tubing, diaphragm actuator uses air as the working fluid. Air pressure is not critical. When the con-



trol valve is shut, pressure in chamber 1 moves both diaphragms to the right. When the control valve is open, the orifice drops the pressure in chamber 1 to

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caster, Pa., or Eastman Chemical Products, Inc., subsidiary of Eastman Kodak Company, Kingsport, Tenn.



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See Sweet's 1961 Product Design File 10d/Ea.



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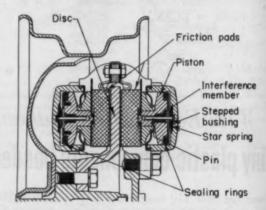
BELL & GOSSETT COMPANY Dept. GV-67, Morton Grove, Illinois

NOTEWORTHY PATENTS

approximately atmospheric, but pressure in chamber 2 remains at that of the air supply. Diaphragms then move to the left. Reason: Full pressure acts on the washers, but pressure forces on diaphragms are borne half by the movable elements and half by the housing. Consequently (with plus denoting forces acting to the right) the net force is $\Delta P[(A-B)/2] - \Delta P[(A-NB)/2] - \Delta P(NB-B) = \Delta P[(B-NB)/2]$. Since N is greater than 1, the resultant force is negative and to the left. Patent 2,997,029 assigned to Thomsen Supply Inc., Los Angeles, Calif., by Richard D. and Marvin D. Bennett.

Automatic Brake Adjuster

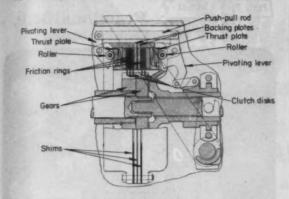
Brake clearance is controlled by an automatic brake adjuster, but wobbling or vibrating brake discs can move the friction pads away without damage. The piston, actuated by hydraulic fluid to operate the brake, can slide along a pin toward the brake disc, but cannot slide back because of the interference member. Head of the pin is held by a star spring and stepped bushing.



but movement toward the brake disc of 0.005 to 0.010 in. (normal brake clearance) is permitted before the spring and bushing contact a fixed closure cap. Thus, when brake clearance is excessive, the piston slides on the pin. But when braking pressure is released, the star spring returns the pin and piston only 0.005 to 0.010 in. However, if the brake disc should strike the friction pad, the piston can move freely away from the disc, since the pin is freely movable in the star spring, and head of pin can move into a recess in the housing. Patent 2,997,137 assigned to Dunlop Rubber Co. Ltd., London, England, by Harold Hodkinson.

Quick-Shift Disc Clutch

Overcenter disc clutch for two-way shifting operation can be engaged or disengaged without slowing drive speed. Sharply angled cam bearing surface on thrust plate causes large thrust plate displacement with small movement of actuating roller when shifter lever is moved in either direction. Spacing between roller pivot pins and length of push-pull rod keeps both sides of clutch from being energized at the same time. Shims are manually inserted between backing



plates to compensate for disc and friction ring wear, supplementing self-adjustment feature of conical-disc springs. Patent 2,993,576 assigned to Allis-Chalmers Mfg. Co., Milwaukee, Wis., by Robert Carlin and Robert G. Honeyager,

Controlled-Clearance Gear Pump

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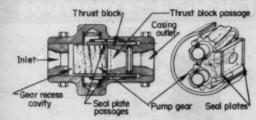
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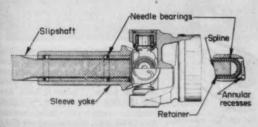
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Output pressure controls the fluid seal between gears and mating parts in a pump designed for high gear speeds and high outlet pressure. Differential pressure operating on the casing outlet side of a thrust block forces the block against the gear teeth, minimizing



clearance between the teeth and the block. Floating seal plates are forced against the side faces of the gears by output pressure fed to a sealed off area on the outside of the plates, thus controlling the seal at both the gears and the thrust block. Patent 2,996,999 assigned to Hupp Corp., Cleveland, Ohio, by Walter C. Trautman.

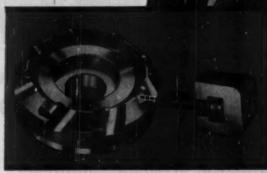


Needle-Bearing Spline

A female spline groove on the slipshaft and a male spline on the sleeve yoke provide the races for needle rollers to run on. A retainer guides the needles and recirculates them. Patent 2,995,008 assigned to Dana Corp., Toledo, Ohio, by Philip J. Mazziotti and John A. Kauser.

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Circle 432 on Page 19



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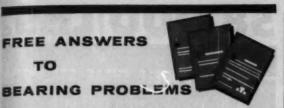
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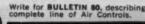
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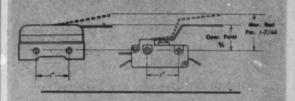


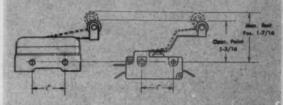
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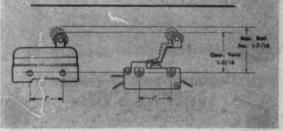
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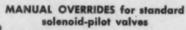


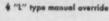
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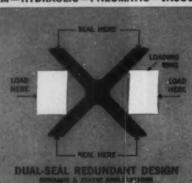


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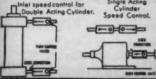


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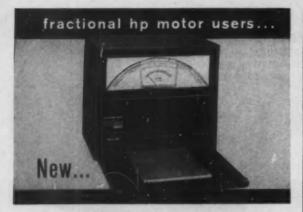
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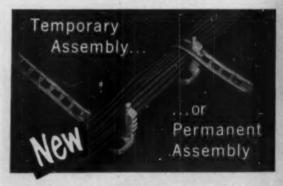
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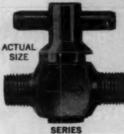
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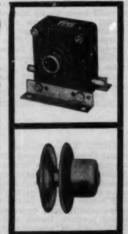
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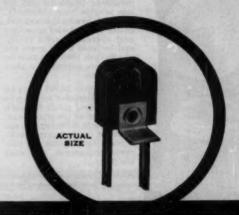
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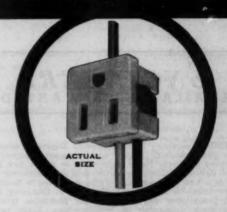
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backtalk-

-Big Figures

A recent packet from Frigidaire on "The Meaning of Reliability" included a booklet with illustrated examples of product life tests. Always impressed by things so numerous that if they were placed side by side would reach to the moon, we read the following comparisons with great fascination:

The vane spring in a refrigerator must function nearly 13 trillion times during 20 years of use. In doing this, the spring produces 286 million foot-pounds of energy—enough to lift two diesel locomotives to the top of the Washington monument.

The snubber spring in Frigidaire's automatic washer is compressed and released over 37 million times during the product's lifetime. Operating on the end of a pogo stick, one of these springs could take a traveler on a round trip between New York and Los Angeles.

The pump and spray tube of a dishwasher, in 15 years' normal use, circulate enough water to sprinkle the average front lawn 24 hours a day for five months.

The light inside a refrigerator has to go on and off 700,000 times. Frigidaire has test equipment that operates the light switch 100,000 times an hour, chalking up 20 years' use in only seven hours.

According to this last item, our refrigerator is opened 96 times each day. No wonder our belt will not go around us one time after 20 years of this!

-Search for Senior Cylinders

If you are acquainted with an air or hydraulic cylinder that has been employed by your company for a long time, you could be \$100 richer come the end of this year. Here's how-and why: The Hanna Engineering Works is 60 years old this year and is celebrating by offering prizes for old Hanna cylinders still in use. The person reporting the oldest cylinder will receive \$100, and his company will get an extra new cylinder any time it places an order during 1962. The same prizes will be given for the second and third oldest cylinders located. If you find an old-timer you think may be a winner, send for an official entry report to Hanna Engineering Works Search Contest, 1765 Elston Ave., Chicago 22, Ill. The contest closes Nov. 30.

-Verification of Verne

Along with the material that was used for our news report on Project Apollo (Page 24), the Martin Co. sent this moon-rocket illustration. It's a woodcut used in Jules Verne's From the Earth to the Moon Scribner's (Charles Sons edition, 1868), and it shows auxilrockets being fired preparatory to a lunar-landing attempt. Verne's capsule, like the Apollo was a three-man



affair; it was going to circle the moon and come back in 11 days (a couple of days sooner than a circumlunar Apollo); and its launching site was Tampa Town, 150 miles from a place called Cape Canaveral.

A true Frenchman, Verne equipped his space ship with a wine cellar. Unfortunately, his astronauts would never have had the opportunity to enjoy it—their launching from a 900-ft long gun would have sent them off at a velocity of 48,000 fps, reducing them to a pulp within seconds, says Martin.

You can't criticize Jules Verne's imaginative powers, and his crystal-balling is downright amazing. But he could have used a couple of good twentieth-century design engineers.

Tips and Techniques

Puncture Protection

To prevent serious injury to the draftsman's eyes and head in general as he dozes off while holding a pencil upright, the following simple device is very effective. Purchase oft sponge rubber balls approximately 1½ in. in diam, pierce with a sharp tool or nail about half way through, and insert pencil.

—Daniel McCarthy, East Troy, Wis.





How wood engineering helps improve skiers in July

THE "BONGO BOARD" (above) is an exercise and balancing device which, among many other recreational uses, is popular with skiers as an off-season training aid.

When Bongo Corporation came to Gamble Brothers, seven years ago, they needed a supplier who could produce platforms and rollers which would retain dimensional stability despite repeated twisting and hard pounding; which would not scuff carpets or damage floors when used inside; which would operate smoothly and quietly; and which could be produced at low unit cost. Gamble Brothers' facilities and experience "filled the bill" then, and still do now.

Problems like this are "all in a day's work" to the wood engineers at Gamble Brothers—a unique organization designing and building a wider variety of wood products than any other U. S. woodworking company. Today they're working in three principal areas: (1) improvement of present wood products (2) development of new wood products (3) product development in combinations of wood and other materials.

Why not present your design problem to Gamble Brothers? WOOD may be the answer!

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This 28-page booklet describes Gamble facilities and services in detail. Includes many photographs of unusual products designed, tested and perfected by Gamble Brothers. Write for your copy today! Gamble Brothers, Inc., 4619 Allmond Ave., Louisville, Ky.





If the problem involves wood, Gamble can help!

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We furnish gearmotors—using standard odd or even ratio gear reducers—providing the exact speed-torque output

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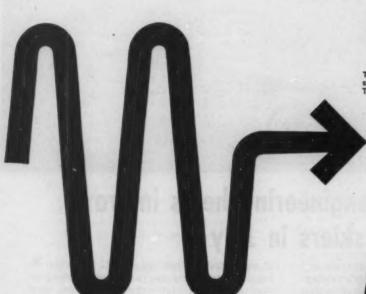
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TYPE FC Small motor rated 1.6 oz. in, max. sync. torque. Size: $1\%_4''$ dia. x 2%'' long. 13.4 oz. To 200 v. a. c. 2, 4, or 6 poles. 101 std. gear ratios.



TYPE LC Small motor rated 10 oz, in, max. sync. torque. Size: $3\frac{1}{3}$ " dia. x $3\frac{1}{3}$ " long. 53 oz. To 200 v. a. c. 2, 4, or 6 poles. Gearing to order.

Hostorn BRASS

(Before)

Clin BRASS

(After)

The letterheads have been printed, signs made... and here we are wearing a new name. But in the mills things go on pretty much as they always have. We've put in some new machines and broadened our line... but essentially it's the

ficient f good

25

people at Western (oops!) Olin Brass that really make the product. They care. That's the "Tailor-Made" approach.

If you're an old customer you know what we mean. If you're not – ask one of our users. Chances are he'll tell you the uniform quality and individual engineering of his metal has managed to save him money in inspection, fewer rejects and less lost time.

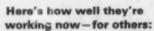
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(Brass seles headquarters at East Alton, Illinois)

METALS DIVISION Olin 400 Park Ave., New York 22, New York.

when you design-in C/R Sirvon* Piston Rings



Case 1 -: n air: Two split Sirvon rings in one groove were used in a small portable compressor under these conditions: speed 1725 rpm, stroke .352", pressure 75 p.s.i., output air temperature 100°F. No lubricant. After discontinuance of testing at 2000 hours, the rings were still in excellent condition, functioning perfectly. Other applications require only a single

Case 2 - In oil: A leading farm equipment manufacturer has tested and approved C/R Sirvon solid rings for a hydraulic application at pressures up to 2000 p.s.i., and shock pressures to 2500 p.s.i, in fluid equivalent to S.A.E. #10 oil. (Rings have been applied in special cases under pressures up to 8000 p.s.i.)

Consider these advantages

Right now Sirvon rings are permitting important cumulative economies in pneumatic and hydraulic units for both manufacturer and user.

- 1. Sirvon rings can run bone-dry where oil might contaminate the system.
- 2. Friction loss is greatly reduced by the low coefficient of the base resins.
- 3. Low-friction Sirvon rings greatly increase service life - eliminate cylinder scoring.
- 4. Piston design is simpler, less costly.
- 5. Ring installation is simple, assembly costs less.
- 6. Leakage is reduced.

Further, Sirvon rings are practicable for use in almost any air, gas, or fluid medium. They are inert to all commercial chemicals except hydrofluoric acid and molten alkalies, and will operate at temperatures from -400 to +500°F.

Why C/R Sirvon Piston Rings? Because Chicago Rawhide is already an acknowledged leader in the field. C/R has experience in the complex technology required for compounding, molding or extruding piston rings with correct thermal stability, wear resistance and dimensional accuracy. In short, C/R knows hownow - and is producing dependable t in large quantities for major users. Sirvon engineers will welcome the op tunity to work with you.

Free sample: Tell us the size ring would like to see. We'll send you a sample Sirvon ring in that range. No o gation, of course.

""SIRVON" C/R's trade name for fluorocarbon resin based dame.
In this case the base was "Teflon" (Du Pont Registered



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